CEPHALO PELVIC DISPROPORTION
In The
AFRICAN PRIMIGRAVIDA

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SUMMARY

INTRODUCTION

Cephalopelvic disproportion, a major cause of perinatal death and morbidity in Africa, is notoriously difficult to assess both ante-natally and in labour.

Recognising the limitations of medical personnel and equipment in Africa, a simple method of diagnosis and management is required, Professor Philpott with his introduction of the partogram and the "Alert Line" (1972), to African obstetrics has produced a simple screening device. This enables even a remote and inexperienced midwife to detect the primigravid patient with cephalopelvic disproportion early, and to refer her into the nearest hospital.

Once in hospital, with the cervicograph across the "Action Line" (Philpott and Castle, 1972) and in the absence of complications other than dysfunctional labour and possible disproportion, active management should be instituted and an Oxytocin augmented Trial of Labour commenced. This "Trial of Oxytocin" must be closely controlled and the infant delivered at the correct time and by the correct method.

OBJECTIVES OF THE STUDY

This investigation, was carried out under a Research Fellowship from the University of Rhodesia, over an eighteen month period in Harari Hospital. In it, certain features of the "Trial of Oxytocin" in the African Primigravida were studied, the better to equip, in particular, the non-specialist doctor working in remote areas to improve his understanding and management of the problems presented by cephalopelvic disproportion.

The dimensions of the African pelvis were examined by X-ray to

decide whether or not the appropriate mode of delivery following Trial of Labour, had reflected accurately the degree of pelvic contraction present.

From the X-rays, the main features of the pelvis were described. The role of X-ray pelvimetry in the African context was then discussed.

The specific fetal responses to the possible excessive head compression encountered in cephalopelvic disproportion were identified, particular attention being directed to fetal heart rate pattern evoked and the degree of head moulding produced. A method of objectively quantitating the amount of moulding was described.

Finally, clinical observations to guide the doctor managing Trial of Labour, to decide on the correct time of delivery, and the optimum mode of delivery were evaluated. The fetal response, as evidenced by the fetal heart rate pattern and the presence of meconium; the dosage and use of Oxytocin; the level and rate of cervical dilatation; the level and rate of head descent; and the amount of moulding and caput, were considered.

MATERIAL AND METHODS

One hundred and eleven, at term, primigravid African patients who were otherwise normal but whose cervicograph had crossed the Action Line, were subjected to Oxytocin augmented Trial of Labour. Each patient had an epidural analgesic, was closely observed in labour, and was monitored using the Hewlett Packard cardiotocograph and fetal blood sampling. Delivery was either spontaneous, by Caesarean Section, by Symphysiotomy, or Instrumentally assisted. Timing and mode of delivery were determined by the state of the fetus and progress in labour.

The labours were scrutinised in retrospect and where any problem had developed which could have affected the fetal response or influenced mode of delivery, the case was set aside. There were twenty-nine such labours.

From the remainder, where dysfunctional labour and probably cephalopelvic disproportion were the only complicating features, three groups - major cephalopelvic disproportion, minor cephalopelvic disproportion, and dysfunctional labour without cephalopelvic disproportion - were created, depending on the mode of delivery.

The control group of twenty-nine consecutive primigravida, where pregnancy, labour and delivery had been normal, was used to provide a measure of the normal parameters in labour in the African primigravidae delivered at Harari Hospital.

To provide a hypoxic pattern against which to compare the fetal heart rate patterns of these various groups, the fetal heart rate traces from twenty "high hypoxic risk category" patients who had shown either low apgars or low pHs, were analysed.

CONCLUSIONS

The Principal conclusions were as follows:-

RADIOLOGICAL PELVIC DIMENSIONS AND THE OUTCOME OF TRIAL OF LABOUR

Clinical judgement as to the degree of cephalopelvic disproportion, based on the outcome following an Oxytocin augmented Trial of Labour, was supported by the differing radiological pelvic dimensions, and shown to be correct.

The African pelvis as seen at Harari Hospital, was found to be small in all dimensions, even among the control group. In all cases the pelves were predominantly gynaecoid in shape, shallow in depth, with straight pelvic side walls, and a high angle of brim inclination. The experienced observer could assess the inlet area from the outlet, the more accessible lower pelvis tending to mirror the inlet.

X-ray pelvimetry was considered unnecessary in the African primigravida, where there was no complication other than possible cephalopelvic disproportion. Where Trial of Labour was thought to be unjustified or dangerous, however, as in breech presentation; where there was a scarred uterus; and in the multiparous patient, where cephalopelvic disproportion was suspected because of poor cervicographic progress, X-ray pelvimetry would be desirable. In such situations, the pelvic dimensions in the various groups of this study, could be used to prognosticate.

SAFETY OF TRIAL OF OXYTOCIN

Full Oxytocin augmented Trial of Labour was not possible in 25% of the cases reported due to additional complications which influenced timing and mode of delivery. However, overall, the trial of Oxytocin proved relatively safe to mother and fetus. There were no maternal deaths and only one neonatal death, out of the series. The infant which proved to be small for dates should not have been subjected to Trial of Labour. All other babies at time of discharge from Hospital appeared healthy.

FETAL RESPONSE TO CEPHALOPELVIC DISPROPORTION

The fetal response to continuing labour in the presence of cephalopelvic disproportion was measured in terms of the fetal heart rate pattern, as detected by the cardiotocograph, the fetal blood pH, the amount of head moulding, and the presence or absence of meconium in the liquor. Although sophisticated equipment was used to analyse fetal heart rate pattern, in fact this could be detected clearly by careful use of the fetal stethoscope or sonic aid.

Initially the fetus responded with "early prolonged" fetal heart rate decelerations. These continued and as labour progressed in the major cephalopelvic disproportion group, the late decelerations and falling pH typical of hypoxia developed. The early prolonged dip was a steep deceleration which started early, had no time lag between the lowest point of deceleration and the peak of the contraction, and returned to the base line rate late in relation to the end of the contraction.

To describe the amount of head moulding present, an objective scoring method was established. A score of 6 was considered to represent marked moulding. If the patient were still undelivered after a further two hours of strong contractions, with no descent of the head, then it had become excessive. On its own account, excessive moulding should be regarded as a sign of fetal distress.

Meconium was present in over 50% of labours where there was significant disproportion in patients with no other obstetric abnormality. Therefore, meconium developing in prolonged labour should be taken into consideration as an additional index as to the degree of cephalopelvic disproportion present.

DURATION OF TRIAL OF OXYTOCIN

The outcome invariably became apparent within six hours of stimulating labour. In many cases, there was need for intervention before six hours had elapsed, as was shown either by fetal distress already described, or by signs of impending obstructed labour. This could be detected where the head was still high with a score of six pluses of moulding present for more than two hours, or where, after six hours, the rate of cervical dilatation had been minimal. The development of a "pelvic" caput indicated major cephalopelvic disproportion.

MODE OF DELIVERY

The decision as to the method of delivery was of paramount importance.

Simple principles had to be adhered to:

Assisted deliveries should never be difficult or traumatic.

Should fetal distress be present and the head not sufficiently low, then any disproportion must first be relieved before delivery is effected. The correct route and mode of delivery will depend on the fetal condition, the dilatation of the cervix, the head level, and the moulding score. Finally, the suitability of the patient for Symphysiotomy, were this indicated, must be considered.

THE PROBLEM MULTIPARA

It has been shown that cephalopelvic disproportion in the otherwise normal primigravida can be safely managed with a well controlled Trial of Oxytocin. This fact, however, does not hold for the multipara where cephalopelvic disproportion can be particularly treacherous. Obstructed labour can be preceded by either rapid or slow cervical dilatation and even in spontaneous labour, the uterus may rupture. Oxytocin stimulated or augmented labour would be even more hazardous.

The various clinical parameters discussed in this study - the head level, the degree of moulding, the fetal response, and the clinically estimated pelvic dimensions, or if available, the exact X-ray pelvic and head measurements - must be applied. These indices will facilitate the recognition and make more certain the safe management of cephalopelvic disproportion in the multipara where the rate of cervical dilatation can be so misleading. Further study into this problem is required.

INTRODUCTION

CEPHALOPELVIC DISPROPORTION IN AFRICA

Contracted pelvis is the major problem in African obstetrics. In many parts, pregnancy and labour still carry considerable risk to mother and infant. Obstructed labour (Lister, 1960) (Harris, 1951), and uterine rupture and infection (Lavery, 1955) account for many deaths. Although some races such as the Zulu or the Matebilé are less affected, for most others, the problem is very real. From Uganda, Rendle Short (1960) reported an incidence of uterine rupture in one out of every ninety-three deliveries, probably the highest ever recorded. In Nigeria obstruction in labour is the largest single fatal factor, causing 27.2% of the maternal deaths and 18.8% of the stillbirths (Lister). The Shona tribe who live in the northern half of Rhodesia and Zambia, amongst whom I worked, share this problem of the contracted pelvis. The maternal and perinatal mortality and morbidity are not accurately known, but it is a fact that over a recent two-year period in Harari Hospital, Salisbury, Rhodesia, one maternal death as a result of cephalopelvic disproportion (C.P.D.) occurred every seven weeks; uterine rupture was seen once a week; and each week three new cases of obstetrical vaginal fistulae were admitted for repair to the Gynaecological Unit.

These mechanical difficulties in labour are further compounded by other problems.

MEDICAL ISOLATION

A number of women in labour are still managed in the mud-hut by the elderly grandmother, far from any medical care. A large number will be attended to in Bush Maternity Clinics or small General Hospitals by the medically unsupervised midwife or African medical assistant. A small number will be looked after by the non-specialist doctor, providing total medical care for the community and working in isolation. It must be remembered that, for example, in the remote areas of Rhodesia the doctor to patient ratio is only one to eighty-thousand!

Only a few patients will have the benefit of confinement in a specialist hospital.

POOR GENERAL HEALTH

Dr. Cecily Williams (1954) has described how ignorance and misuse of food can lead to chronic malnutrition, even in places where wheat and milk are plentiful. Such endemic disease as bilharzia, malaria, trypanosomiasis, dysentry and tuberculosis may further debilitate women whose general health is already poor. These women are at particular risk in labour and respond poorly when this is prolonged or difficult. Deterioration in their condition, from dehydration, infection and blood loss, can be sudden and fatal.

Some claim that there is a higher proportion of uterine fibrous tissue in the Bantu than in other peoples. Rendle Short (1960) declares that the Bantu uterus is particularly prone to rupture and attributes this to poor tissue nutrition. The prevalence of multiparity also increases the risk of uterine rupture due, as Munro Kerr (1954) states, to the greater amount of uterine fibrous tissue following each pregnancy.

GEOGRAPHICAL REMOTENESS

Transport difficulties, especially at night, long distances and the inaccessability of many of the villages, add considerably to delay in admission. The roads, mostly earthen, are poor and often impassable during the rainy seasons.

Emergency cases may arrive dead at the hospital, having travelled for one or more days.

TRIBAL CUSTOMS

Medical supervision of pregnancy is often hampered by ignorance and fear. Rendle Short (1956/58) tells how it is considered "bad luck" in parts of Uganda for mothers to divulge details of previous pregnancies.

As all childbirth is regarded as a normal physiological progress, many women still prefer to be delivered at home, without trained assistance. They come into hospital only as a last resort. Grech (1967) reports a custom among the local Africans specifically requiring that the first born be delivered at home.

Rupture of the membranes can be taken as a sign that the expulsive stage of labour has been reached (Lister, 1960) and the woman commences to bear down. This premature pushing can lead to exhaustion, fetal distress, and can cause mechanical obstruction from cervical oedema. In obstructed labour, the "Kanula" (Zulu for "push") syndrome (Lawson and Stewart, 1967) is not uncommon.

If delivery is not accomplished within a reasonable time, the relatives or native doctor may resort to very active and inexpert measures.

The manipulative measures such as the use of fundal pressure, a cause of uterine rupture, can kill. Many tribal societies have a strong fear against burying a woman who had died with the baby still in utero, so great force may be applied to deliver a mother.

Many take native drugs during labour - a concoction of leaves, barks or roots, ground between stones with boiling water poured over, shown (Grech, 1967) to have definite oxytocic action. Other medicinal methods used, include the introduction of leaves, mud, or, for example, cow dung, into the rectum or vagina.

<u>SUPERSTITIONS</u>

To further aggravate the problems, primitive taboos still prevail.

If labour is other than rapid and uncomplicated then the delay can be attributed to punishment for infidelity and strong persuasion may be brought to bear on the woman to confess her guilt.

Vaginal delivery is of such social importance that patients will go to great lengths to avoid the stigma of a Caesarean Section, which to them represents personal failure. It may also mean divorce, as by tribal custom of some, abdominal delivery is associated with infidelity.

<u>MANAGEMENT IN HOSPITAL</u>

The case admitted in neglected obstructed labour will require urgent resuscitation and present major problems of management. However, even with these patients, arriving in good time, there are problems. Refusal of surgical treatment for the reasons already mentioned with, in addition, unwillingness unless a living child is guaranteed, and great fear of not awaking from the anaesthetic, present major difficulties. For the doctor too, the anticipation of a ruptured scarred uterus in the subsequent labour away from hospital may cause him to hold his hand before embarking too readily on surgery.

In this whole situation, therefore, urgent changes are needed. Community health and education, road communications and medical and nursing staffing, must be improved. Most important at present, simple medical rules are required to provide clear guidelines for treatment.

The two major requirements are, first, to recognise the patient with the mechanical problem of cephalopelvic disproportion, and second, to manage it correctly.

Before further discussing the problem in the African context, for the purpose of clarity and interest, it is necessary first to define cephalopelvic disproportion; to trace the sequence of events in normal labour; to review the natural sequence of events which will accompany labour in the presence of cephalopelvic disproportion; and finally, to establish the extent to which the problem of cephalopelvic disproportion has in the past affected and directed British obstetrical practice.

DEFINITION

Cephalopelvic disproportion exists where the relative sizes of fetal head and maternal pelvis are such that the former cannot or may only with difficulty pass through the latter. The head (for example, in hydrocephalus) or its presenting part (for example, the brow) may be abnormally or excessively large. By convention, however, and in this investigation, only the normal head which presents by the vertex to a contracted pelvis, is considered.

FEATURES OF NORMAL LABOUR

Before embarking on a study of the abnormal labour, the process of what is accepted as being normal must first be described and defined.

In normal labour the fetus will present by the vertex, pass through the pelvis with ease and deliver spontaneously as a vigorous, healthy infant.

In primigravidae, the two phases of the first stage of labour, the latent and the active (Friedman, 1954) should not exceed eight hours and six hours respectively - the latent phase being from the time of onset of regular contractions (every ten minutes) up to the point where the cervix steadily dilates, which has been found to be at 3 cms. The active phase extends from 3 cms. to full dilatation of the cervix.

The second stage of labour, from full dilatation of the cervix to delivery of the infant, should not exceed thirty minutes.

In multiparae, each interval will be shorter.

Of the various factors concerned, the pelvis, the fetus and the uterus will be briefly considered in turn.

PELVIS

The normal pelvis is capacious and the majority are gynaecoid or round in type. Diagram 1 describes the four parent types of pelvis described by Caldwell and Moloy (1933). For the convenience of description, the pelvic cavity is divided into three planes, the inlet, the mid-cavity, and the outlet. Diagram 2 shows the three levels. At the inlet the transverse diameter is greater than the antero-posterior diameter. In the mid-cavity, the diameters are approximately equal, and at the outlet the antero-posterior exceeds the transverse. (Diagram 3).

In pregnancy the joints are made more lax and in labour pelvic moulding occurs more readily to accommodate the head as it descends. (Rohan Williams, 1957).

THE HEAD

In normal labour, the head, the largest part of the fetus will present to the pelvis by the vertex. In the majority of cases, it presents in a position close to the transverse, so that its smallest diameter at the brim, the bi-parietal diameter, will present to the smallest pelvic diameter, the antero-posterior inlet. Its potentially larger antero-posterior diameter, e.g. the occipito-frontal (See Diagram 4) will then present to the transverse diameter of the pelvic brim.

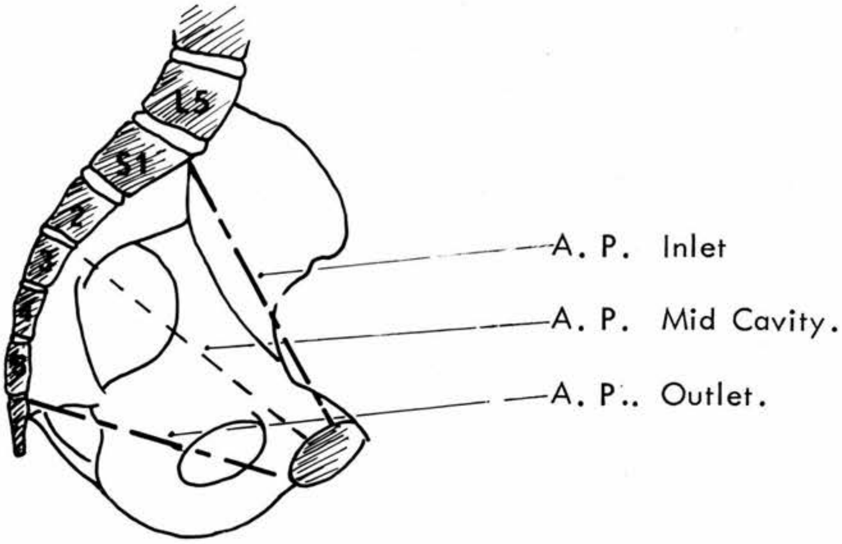


DIAGRAM 2. Lateral view of Pelvis

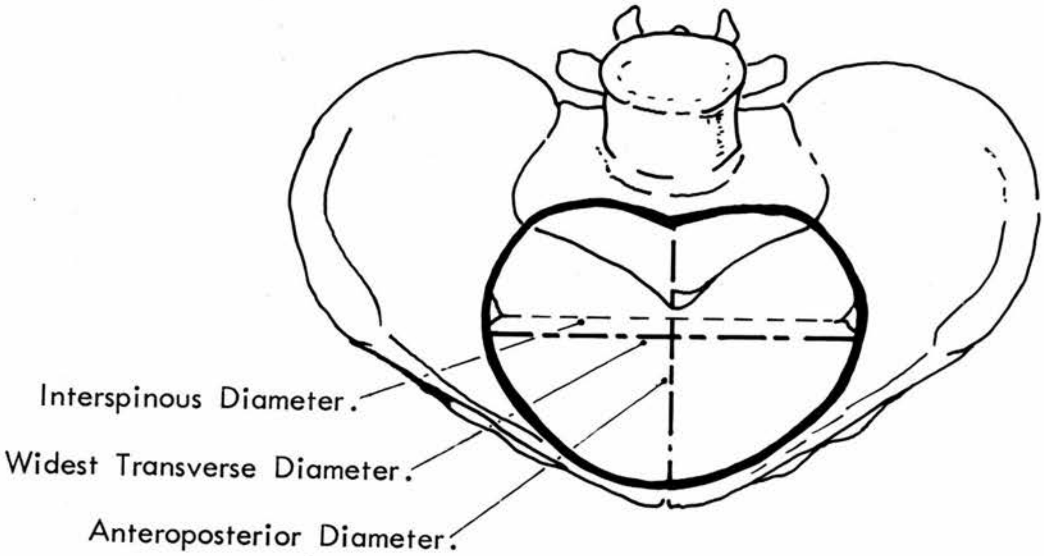
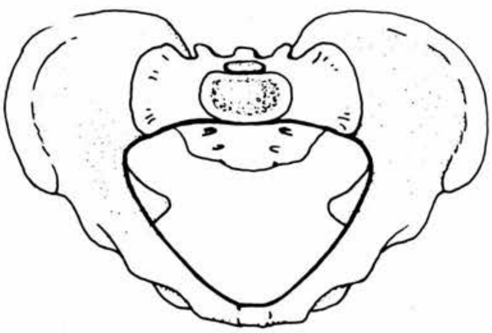
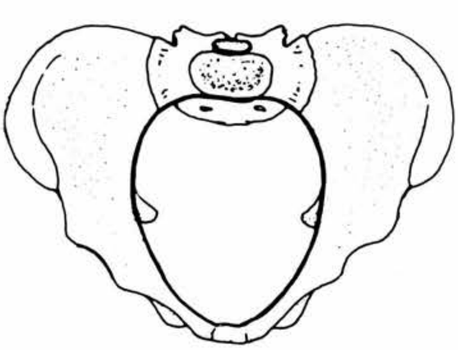


DIAGRAM 3. Antero - posterior view of Pelvis.

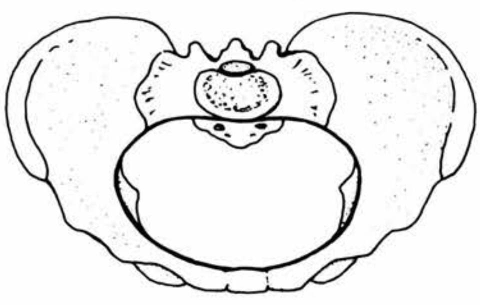
Gynaecoid



Android



Anthropoid



Platypelloid

DIAGRAM 1. The four parent Pelvic types.

During its subsequent descent, with increasing flexion, the smallest sub-occipital bregmatic diameter is achieved (Diagram 4) and the head rotates in what is known as the mechanism of labour to come to the outlet in the occipito-anterior position. In this it is aided by the gutter shape formed by the levatores ani and the pelvic floor, which cause the leading point of the head (the vertex) to be directed anteriorly.

During its descent, to create the smallest presenting diameters, as well as flexing, the head moulds. Moulding describes the ability of the head to change shape so that its presenting diameters become smaller. It occurs by closing or over-riding of the bones at the membranous joints or suture lines (Diagram 5 and Plate 1).

In labour, a moderate caput succedaneum will form, due to venous compression on the presenting fetal scalp by the cervix, with consequent oedema formation (Diagram 6).

THE UTERUS

The uterus can be considered functionally to consist of two components, the upper and the lower segments. In normal labour the active upper segment contracts and retracts; the passive lower segment is pulled up, and becomes thinner; the cervix first effaces then dilates. (Diagram 7).

In labour, to achieve fetal descent and delivery, the uterine contractions must overcome the resistance to dilatation of the lower segment and cervix and also the resistance of the pelvic birth canal. Regular in shape and frequency the contractions increase in frequency and intensity through labour, until at the end of the first stage they occur about four in every ten minutes, and their amplitude can reach up to 80 mms. of mercury, with a duration of forty to sixty seconds. Between contractions, the uterus relaxes, the resting tone averaging between 0 and 10 mms. of mercury.

In the second stage of labour, the "secondary powers" of abdominal wall and diaphragmatic muscle contraction, are added to the uterine contractions, to finally expel and deliver the fetus. During the second stage, contraction amplitude can exceed 120 mms. of mercury (Turnbull 1957)

MOTHER AND INFANT

In normal labour the mother, suitably supported against pain, should be free from keto acidosis and dehydration. Her pulse, blood pressure and temperature, should remain normal.

The fetus should show no clinical evidence of distress - the liquor should remain clear, the fetal heart rate regular in rate between 120 and 160 beats per minute, and the infant at birth should present with an Apgar Score of greater than seven at one and five minutes.

The above account applies to the normal progress of labour in the European patient. The same sequence of events may not necessarily apply to other ethnic groups, and in the investigation to follow, the sequence of events in "normal" labour in the Rhodesian African primigravida, is further evaluated.

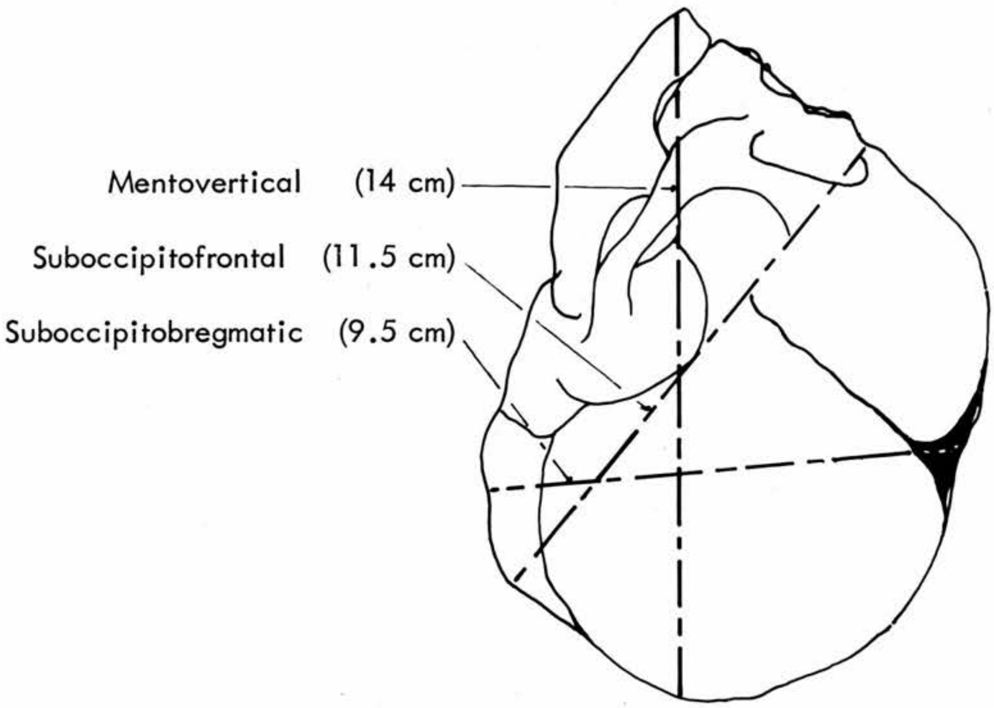


DIAGRAM 4. Dimensions of the Fetal Head.

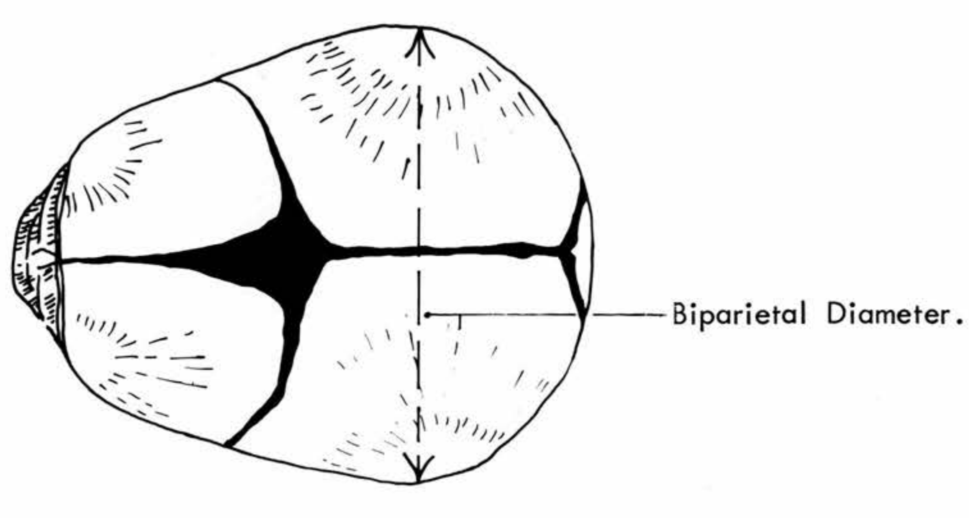


DIAGRAM 5. Suture lines on the Fetal Head.

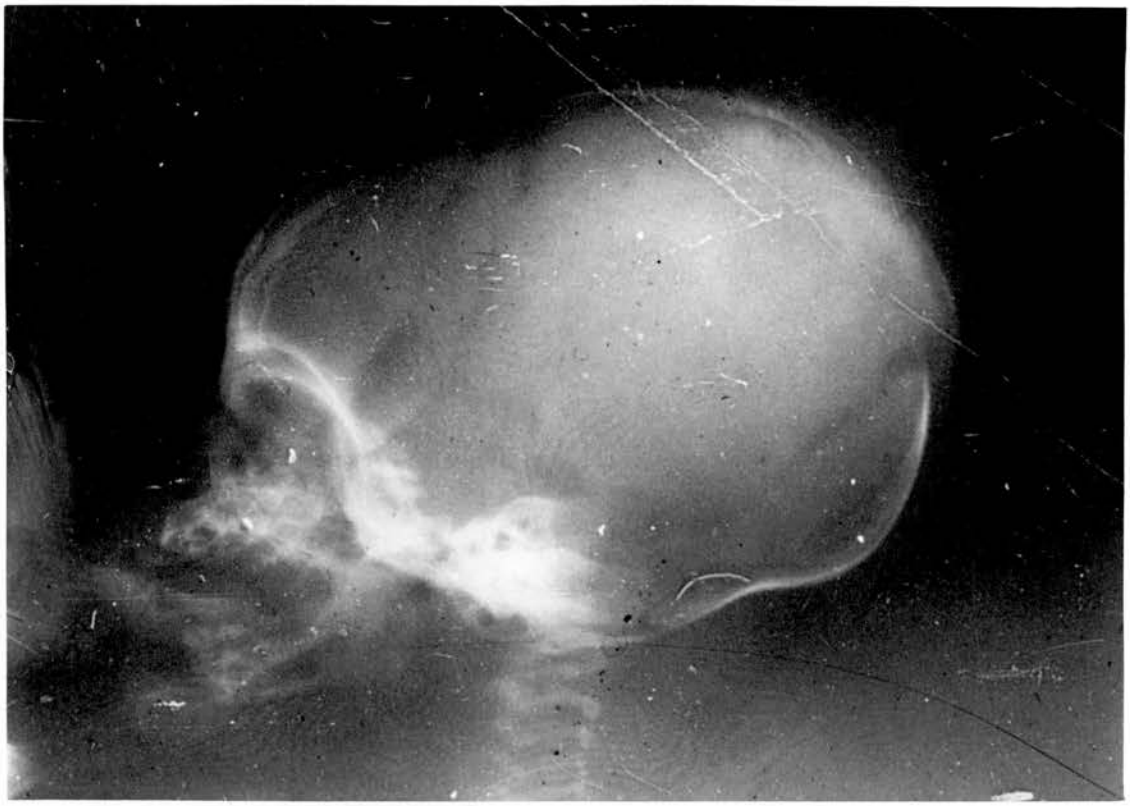


PLATE 1. Moulding of the infant's skull at birth.

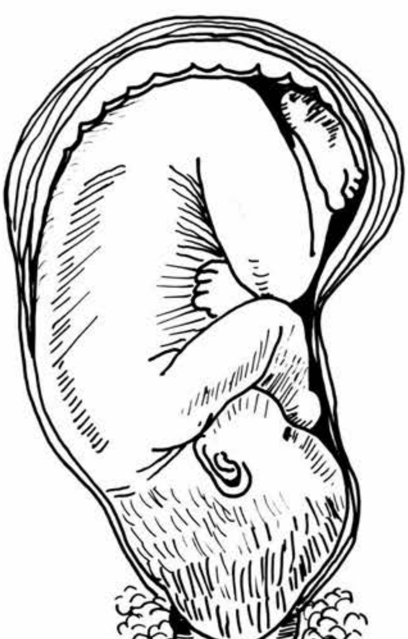
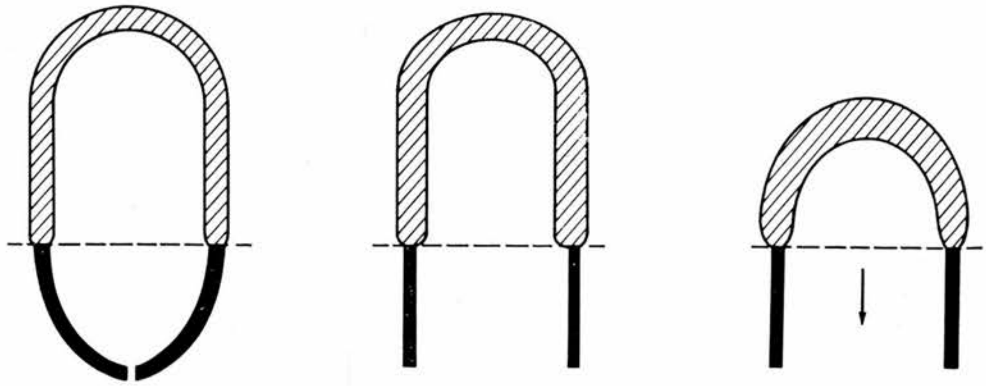


DIAGRAM 6. Cervical Caput Formation



a **b** **c**

a. At the onset of Labour

The lower segment is almost a hemisphere.

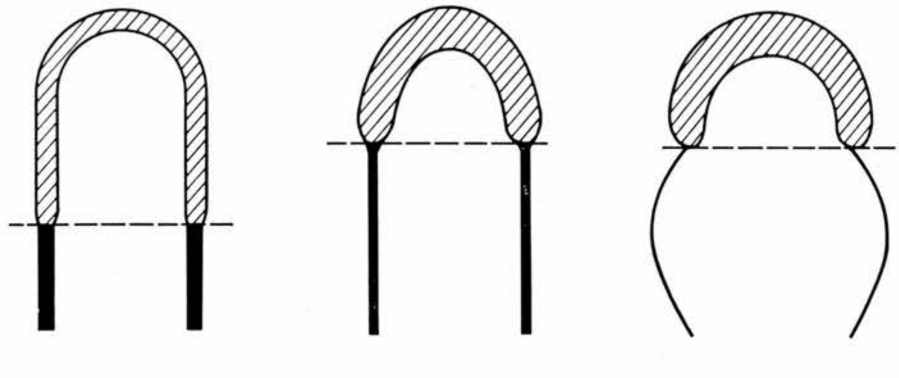
b. At the onset of the second stage.

The Cervix is fully dilated.
The upper segment is thickened by retraction.

c. During the second stage.

The upper segment further retracts and thickens.
The lower segment does not elongate.

DIAGRAM 7. The Uterus in Labour.



a **b** **c**

a. Prior to Obstruction

b. Developing Obstruction

The already thinned lower segment elongates.

c. Established Obstruction

Further thinning with distension of the lower segment.

DIAGRAM 8. Changes in the Uterus in Obstructed Labour.

THE NATURAL OUTCOME IN CEPHALOPELVIC DISPROPORTION

In obstructed labour, the fetus acts as a splint which keeps the length of the uterus constant and, since each contraction is followed by slight retraction, it follows that the upper segment becomes retracted and thicker. The lower segment must then become thinner and elongates. (See Diagram 8). The importance of the fetus acting as a stretcher and maintaining the uterine length was stressed as an important part of the process of obstructed labour by Kerr,Johnstone and Phillips (1954). Eventually with the placental site continuously retracted, the fetus in addition is further compromised by lack of oxygen.

The clinical features in cephalopelvic disproportion will depend in part on the patient's parity. In the European primigravida, from clinical (Jeffcoate, 1950), (McLennan, 1944) and electronic (Caldeyro Barcia et al, 1955), (Turnbull, 1957), observations, the uterus after initially contracting, develops hypotonic inertia; it then, after a time, contracts again and retracts to eventually become inert in a retracted state, wrapped around the fetus. Infection sets in.

The fetus, battered and asphyxiated and infected, may die in utero. It may remain undelivered or, with maceration and subsequent give of the fetal skull, spontaneous vaginal delivery may occur, nature's final solution to the problem.

For the mother, first, anxiety then exhaustion, fear, dehydration, and sepsis develop.

Dehydration follows an inadequate fluid intake in the presence of muscular activity and excessive fluid loss due to pyrexia in labour. The skin is hot and dry, the lips are cracked, the tongue furred and the urine concentrated. Metabolic acidosis also develops because of lactic acid accumulation (Sammueloff, 1961) in the contracting uterine and skeletal muscles. Catabolism of endogenous fat due to inadequate carbohydrate reserves, adds to the acidosis, which is further exaggerated by the dehydration and accumulation of anions following a reduced urinary output. In an attempt to restore the acid base balance, potassium is mobilised from the cells, with a consequent reduction in involuntary muscle activity. The patient presents with tachycardia, deep rapid respirations, acètonuria and bowel distension.

Even in the absence of vaginal intervention, if labour be sufficiently prolonged, birth canal infection, which may be clostridial, will occur with accompanying hyperpyrexia and offensive vaginal dis-:charge - the organisms normally commensal in the bowel, having become pathogenic. The patient undelivered will die from dehydration, sèpsis and shock.

In the multipara, a different, more complex and even more urgent situation prevails! The uterus will strive to overcome disproportion. The contractions will become increasingly frequent and strong until there is no further uterine relaxation. The upper segment will have retracted fully at the expense of the lower which is stretched to the limit and beyond (Diagram 8). The uterus ruptures. Both mother and child die. (McLennan, 1944).

Nature may, however, succeed in overcoming the disproportion and saving the mother, by calling on each of the three components in labour, already discussed.

The uterine contractions may prevail, and force the infant through the contracted pelvis.

<u>The fetal head diameters</u>, presenting to the pelvis, can be reduced to a minimum by an asynclitism (Diagram 9), flexion, excessive moulding and finally, following maceration by collapse.

<u>The pelvic diameters</u>, can be increased to the maximum possible by moulding and they can be further increased by the squatting position (Russell, 1973) - a position instinctively adopted by primitive women in labour!

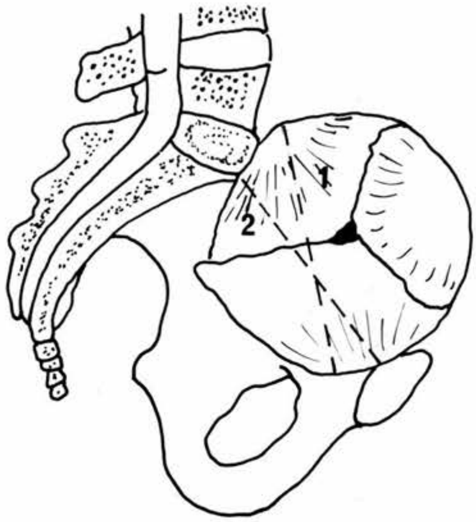
However, while surviving, the mother can be damaged. Autosymphysiotomy as described by Hyslop, (1964) and as seen on Plate No. 2 can occur in obstructed labour, to further enhance the pelvic dimensions. Hyslop, (1964) reported the high incidence of separation of the symphysis pubis amongst African patients around Nairobi as occurring in one out of every two hundred and fifty confinements.

Prolonged head compression on the soft tissues of the pelvis may produce severe necrotic damage and lead to urinary and bowel incontinence from vaginal fistulae.

Other sequelae to prolonged obstructed labour include peripheral nerve injuries with foot drop from prolonged pressure on the lumbo-sacral trunk by the fetal head, and troublesome pressure sores sustained from lying or kneeling for long hours on a hard floor. Less immediately, post-partum amenorrhoea may develop.

Uterine rupture (Plate 3) rarely occurs in the primigravida (Rendle Short, 1956), though Lister (1960) reports three out of sixtyeight uterine ruptures to have been in primigravidae. In these cases doubt-:less, pressure necrosis had played the major part (Jeffcoate, 1950).

In the majority of cases, the infant will come to grief, the cephalopelvic disproportion being overcome only at the expense of the baby, finally delivered dead or dying, from the combined effects of sepsis, intracranial tears and haemorrhage, and asphyxia. If surviving, there may be the tragedy of profound and permanent neuro-:logical damage.



1 = Biparietal Diameter.

2 = Super - subparietal Diameter.

DIAGRAM 9. Asynclitism.

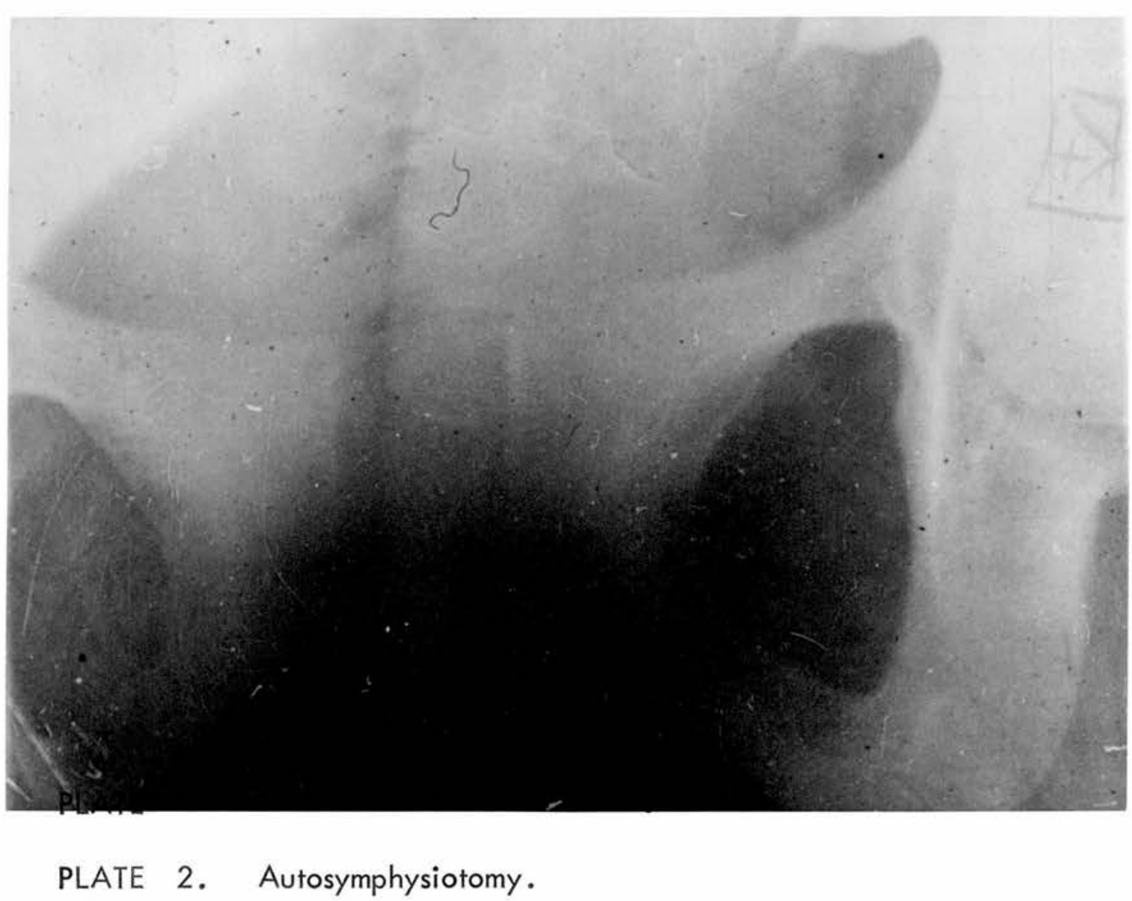
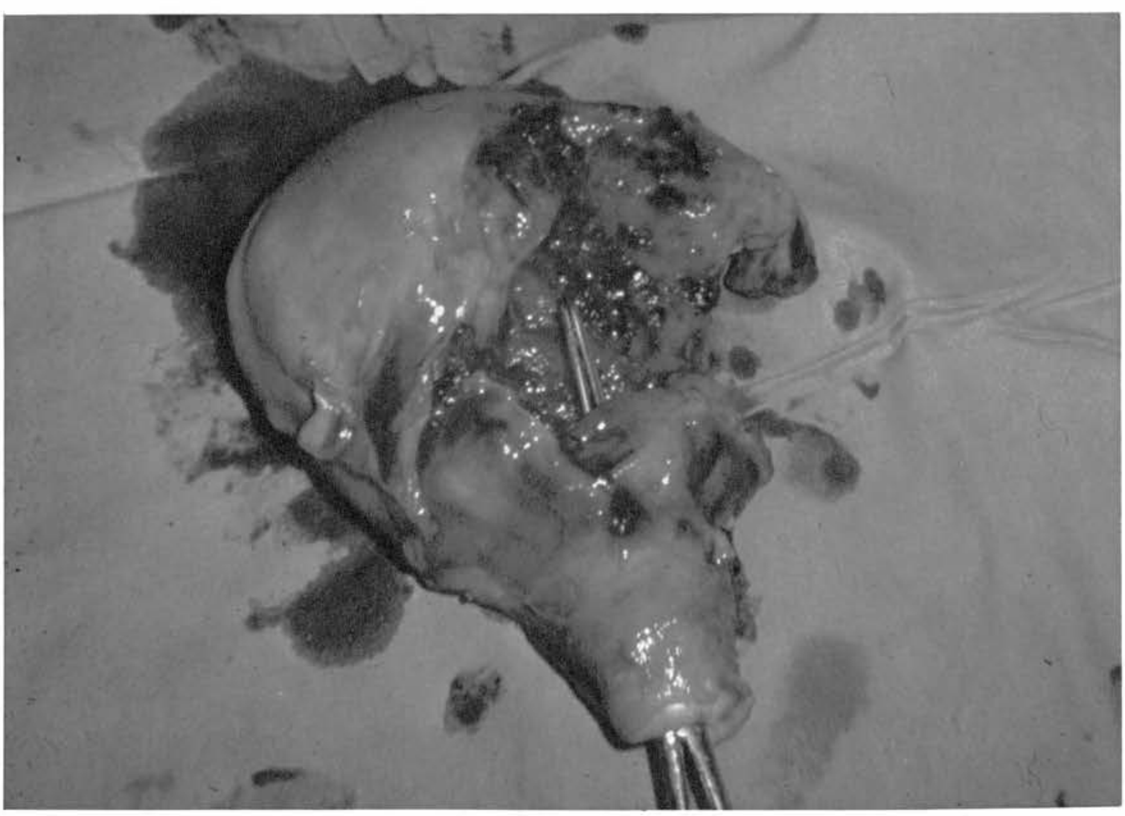


PLATE 2. Autosymphysiotomy.

PLATE 3 (A&B) Rupture of the multigravid uterus.



CEPHALOPELVIC DISPROPORTION IN THE U.K.

Cephalopelvic disproportion has been recorded over the centuries as a major cause of mortality. Chamberlain and Smellie recognised that the conduct of difficult labour required skill and judgement and even with these tragedy followed - usually always for the baby and often for the mother. Because of the appalling results from Caesarean Section, watchful expectancy or "tincture of time" as one nineteenth century writer put it (Eastman, 1950) was the order of the day. The ultimate was reached in 1817 with the delivery of Princess Charlotte (grand-daughter of George III) following a labour of fifty hours (Holland, 1951). With the royal lineage heavily dependent on the outcome the second stage was allowed to continue without interference for twenty-four hours. Princess and baby both died. The obstetrician subsequently committed suicide.

It was not until 1848 that Simpson (1848) pointed out the danger to the fetus when labour is prolonged. He estimated that following labours of thirty-six hours or more, 50% of the infants and 16% of the mothers died. In 1878, Hamilton stated that "- tedious labour - proves harmful to mother and child. This holds good for both, but especially for the latter - - that in such cases, where the labour is allowed to continue long, or to be finished by the pains alone, risk to the child is both imminent and great".

Despite this warning many of our senior obstetricians are old enough to remember the time when serious disturbance of uterine activity most frequently resulted in the death of the baby. As recently as thirty years ago, cephalopelvic disproportion was a major problem in the industrial cities of Scotland, where the standard of living was low, because of the high incidence of rickets then prevalent. McLennan in his Blair Bell lecture of 1944, reported an incidence of contracted pelvis at the Glasgow Royal Maternity Hospital of between 10 and 15% - and these carried with them a stillbirth rate of 22.2% and a maternal mortality of 21 per 1,000 (compared to 3 per 1,000 of the normal group). Looking at 100 maternal deaths, McLennan (1944) divided the cases into various groups:-

Group 1 - death directly due to dystocia and associated with trauma, shock or haemorrhage.

Group 2 - death directly due to dystocia and associated with trauma, shock or haemorrhage, and followed by sepsis or post-operative haemorrhage.

Group 3 - death directly due to the above causes, but with other pathology present which made the patient more vulnerable (for example pyelitis or hypertension).

Group 4 - death due to post-operative pneumonia or other complications after a reasonable labour.

Group 5 - death due to post-operative pneumonia or other complications occurring in early labour.

Groups 6, 7 and 8 - death due to other reasons.

He found that 28% fell into the first group and 22% into the second. In group 1 shock was the most frequent cause of death and in group 2 sepsis or peritonitis was mainly responsible. Of significance was the fact that in 50% of group 1, the degree of pelvic contraction was only minor - the patients had escaped detection, and had become neglected.

These figures demonstrate the magnitude of the problem thirty years ago, but even this represented a big improvement on fifty years before, when an obstetrician had to decide whether a woman with a 5 cm. inlet conjugate could undergo the risk of Caesarean Section, or whether it might not be wiser to perform by choice a craniotomy.

Today in the United Kingdom and the privileged West, where community health in the past years has been greatly improved and, apart from its presence amongst the immigrant Asian population, rickets has largely disappeared, the problem of cephalopelvic disproportion, although still present, is less marked.

The problem of primary dysfunctional labour, which can mimic the uterine dysfunction secondary to disproportion, however still remains. In some centres in the United Kingdom, a radical attitude of Caesarean Section has been adopted. From Belfast for example,(1963) the Caesarean Section rate for cases of abnormal uterine ~~contr~~action, without cephalopelvic disproportion was 80%, there being no fetal loss. Such a policy for inco-ordinate labour can hardly be justified, particularly in the young primigravida, where uterine dysfunction is unlikely to recur in a subsequent labour if the cervix reaches at least half dilatation in the first labour (Jeffcoate, 1961). Caesarean Section even today is by no means free of complications! The maxim of William Smellie (1752) that "it takes more skill to prevent than perform an operation" must be remembered.

In true cephalopelvic disproportion, with modern obstetrical and anaesthetic care, with blood transfusion and antibiotics readily available, the era of accouchement forcé, high forceps, bi-polar version, and other such destructive procedures, has gone. A maternal death attributable to difficult labour should not occur, and emphasis has turned to the welfare of the fetus. Obstructed labour should be rarely encountered in present day British obstetric practice.

It is now mainly in the underdeveloped parts of the world, such as in Africa, that obstructed labour continues to cause havoc in childbirth.

RECOGNITION OF THE PATIENT WITH DISPROPORTION IN AFRICA

Turning back to the African context, in the management of disproportion, the first imperative is to recognise the problem patient early. This, in the primigravida, with the introduction and utilisation of the cervico:graph (Plate 4), Professor Philpott, (Philpott and Castle, 1972) has done with great success.

Amongst the rural African patients, where ante-natal attendance and care are at present poor, prediction ante-natally of mechanical problems in labour is not possible. In any case, clinically the patient's height (Philpott and Castle, 1972) is no reliable guide to pelvic size, and assessment of the pelvic dimensions is notoriously unreliable. The added facts that most institutions are unable to carry out x-ray pelvimetry and that in the African (Glick and Trussell, 1970) the fetal head commonly remains high until the onset of labour (a very unfavourable observation prognostically amongst Europeans), makes it very difficult to define criteria by which to choose the appropriate patient for confinement in hospital rather than in a remote maternity clinic staffed only by midwives.

Recognising that the only way to appreciate cephalopelvic dispro:portion in the African, is during the dynamics of labour, Professor Philpott following the concept first introduced by Friedman (1954) of graphing cervical dilatation against time, applied this method of recording labour to the Rhodesian African primigravida. Of the three parameters, cervical dilatation, head descent and uterine contractions, used for measuring progress in labour, dilatation of the cervix is by far the most reliable and accurate (Hendricks, 1970). E.A. Friedman (1954), (1971) has portrayed labour as consisting of two phases, the latent and the active. The latent phase he described as the period between the onset of regular uterine contractions but "before the onset of appreciable cervical dilatation", there being a slow linear dilatation up to 2 to 2.5 cms. after which active labour began. Philpott accepted active labour as commencing when the cervix had become fully effaced and 3 cms. dilated and, as Hendricks had done, (Hendricks, 1970) he designated time of arrival at hospital rather than the patient's estimate of time of onset of labour, as zero time. From a series of African primigravidae in the active phase of labour at Harari Hospital, Philpott went on to establish the mean rate of cervical dilatation. As cephalopelvic

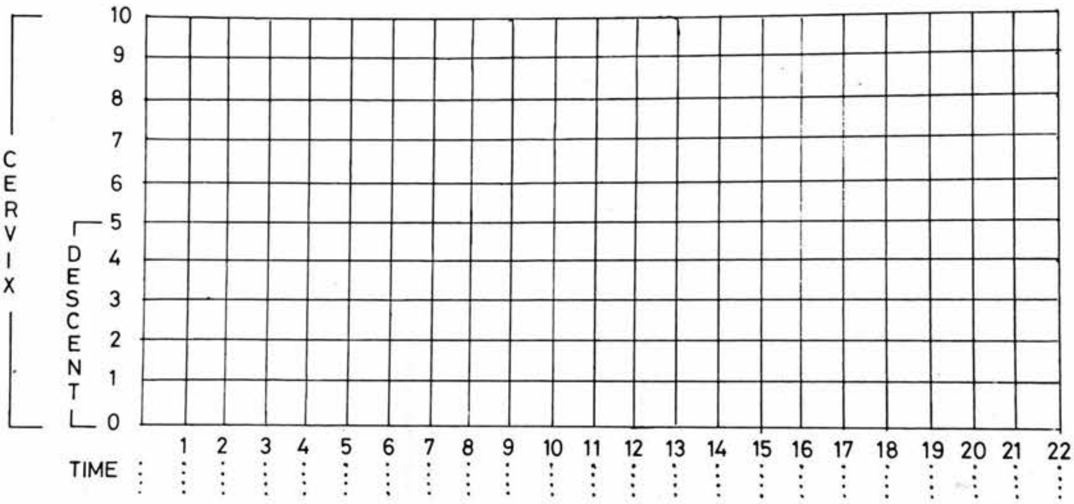


PLATE 4. The Cervicograph.

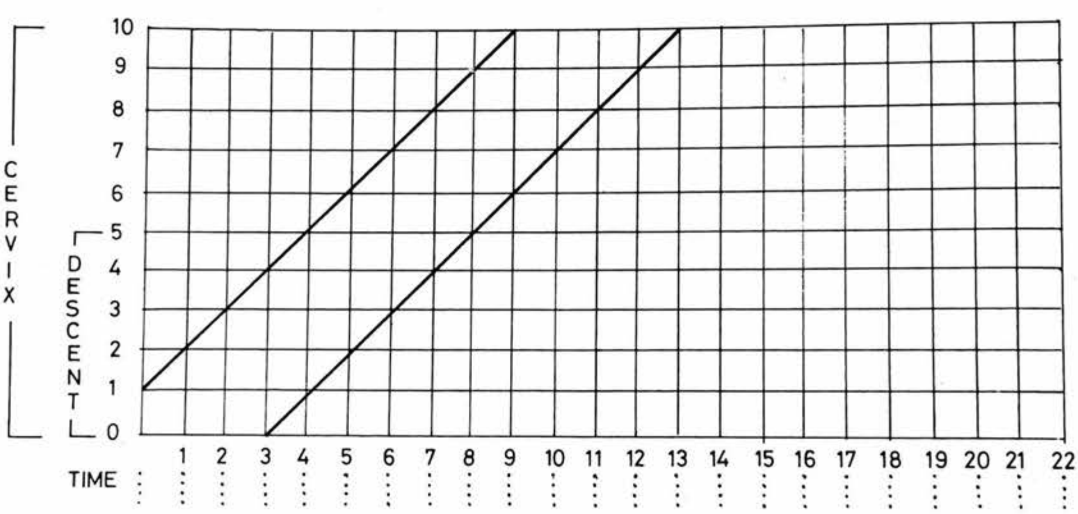


PLATE 5. The Alert and Action lines.

disproportion in the primigravida is invariably manifested in the active phase of labour by slow or absent cervical dilatation (Stewart and Bernard, 1954) the pictorial display of such a pattern provides early and ready recognition of the patient with possible cephalopelvic disproportion. Philpott and Castle, (1972) then established a line representing the mean of the slowest 10% of his normal primigravidae, and this he dubbed the Alert line (Plate 5). The point at which the cervicograph crossed the Alert line, alerted the attendant (perhaps an unskilled African medical assistant in the bush) to transfer the patient to the nearest available medical assistance. A line drawn arbitrarily parallel and four hours to the right was termed the Action line, at which if undelivered, the patient, now in hospital, could be managed actively.

This screening method in labour has proved of immense value in the primigravida. It has produced a simple clear pictorial display of all the relevant details during parturition, providing a reliable and accurate interpretation of the labour process for even those not specially trained in obstetrics. The Alert and Action lines (Plate 5) have established unequivocal guide-lines for management in the prolonged labour. The Alert line (Philpott and Castle, 1972) has been found to separate the normal from the abnormal and the adequate from the small pelvis. The normal patients are allowed to deliver in clinics, the abnormal are transferred to hospitals better equipped to cope. Philpott (Philpott and Castle, 1972) found that the cervical graph of 22% of his African primigravidae crossed the alert line. Of these 50% delivered normally within the succeeding four hours, leaving 11% of the total, who crossed the action line, with a major clinical problem. Thus patients with cephalopelvic disproportion were admitted to Hospital sufficientlyearly in labour, before they or their infants had come to harm.

It should again be indicated to the reader that by Hospital, in the great majority of cases in Africa, is meant a small remote institution staffed by one non-specialist doctor, who himself requires guide-lines in the management of prolonged labour.

MANAGEMENT AND TRIAL OF LABOUR

In the management of these primigravid patients across the Action Line with proven dysfunctional labour, either primary or more probably secondary to cephalopelvic disproportion, the outcome cannot be foretold until the patient has laboured. As labour develops, there occurs a give in the pelvis, a moulding of the fetal head and an adjustment of head to pelvis which cannot be predicted beforehand. Nor can the strength of uterine contractions, the rate of cervical dilatation or the efficiency of the placenta in maintaining fetal requirements, be accurately forecast. For these reasons, where there is no other problem, all patients must be subjected to labour.

A Trial of Labour should be defined as one which is conducted under close supervision to detect the presence and degree of disproportion. It should be completed by instrumental or operative delivery if progress stops, or if the continuing labour presents greater hazard to mother or child.

Trial of Labour is no new concept. Couvelaire in 1892 would appear to have been the first to introduce the phrase, saying "must we then conclude that one should await the Trial of Labour to make thereby an adequate pelvic assessment". Before this, McLintock, in his edition of Smellie's "Midwifery" wrote "La Motte" (1721) "speaks of turning in difficult labours from disproportion and recommends its performance after due trials of the powers of nature to force down the head". In advance of his time, Dice in 1911 stated "primiparae with moderate contraction should be given the test of labour, provided the head can be engaged by "Müller's Method". He added, "the test of labour should be conducted with rigid aseptic techniques such that the best interest of mother and child will be preserved in case operative interference is finally required. If after good pains the head does not mould or advance, operative assistance is indicated."

Trial of Labour, however, as we understand it to-day, only came into being with the advent of reasonably safe Caesarean Section, which in Europe revolutionised the management of cephalopelvic disproportion. There had become for the mother a safe alternative to vaginal delivery. Allen and Hawksworth in 1951 wrote "it appears to us, there is no method of assessment of the inlet level which will allow a firm prediction to be given as to whether or not vaginal delivery will occur" and further "it is our opinion that, provided the presentation is a vertex and there are no other contra-indications, a full trial labour is justified in practically every case of inlet contraction". In the African context from Uganda, Gluck and Trussell (1970) declare that the prediction of the outcome of any labour is difficult and a Trial of Labour is necessary for virtually every patient.

Until the past few years, watchful expectancy had constituted the trial. Management in the prolonged labour had been passive with a wait and see policy. O'Driscoll et al (1969) were among the first to advocate active management, with the use of oxytocic infusion. To avoid the prolonged labour, they advised artificial rupture of the membranes, followed, if necessary, by oxytocin to encourage more effective uterine activity in all primigravidae in whom progressive cervical dilatation was not evident - logically following T.N.A. Jeffcoate's observation (1961) that "nature and time are unreliable allies".

There was, however, a considerable difference of opinion about the safety of stimulating labour in primigravidae, where cephalopelvic disproportion was suspected. The most frequent objection to a policy of active management in labour was the possibility of disproportion (Ledger 1972). Hellman (1959) warned that even minor contraction was the principal contra-indication to stimulation. Turnbull and Anderson (1968) considered the possibility of fetal intracranial damage and recommended oxytocin only when cephalopelvic disproportion had been excluded. Another contra-indication to stimulation, was the risk of uterine rupture (Goldman, 1959), O'Driscoll et al (1969) on the other hand, concluded that the primigravid uterus was almost immune to rupture, having found no report of a ruptured uterus in a primigravida after oxytocin. They did <u>not</u> withhold syntocinon because cephalopelvic disproportion was suspected. However, at the same time O'Driscoll (1973) claimed that the active management had shown most cases diagnosed as cephalopelvic disproportion, to be in fact due to primary inefficient uterine action.

In general, and certainly as regards African Obstetrics, this belief must be mistaken. There is ample evidence, as stressed by Jeffcoate, (1961) and Turnbull (1957) of the strong relationship between prolonged labour and cephalopelvic disproportion, and there is little doubt that borderline cephalopelvic disproportion can be overcome satisfactorily by improving uterine action. More recently, Studd (1973) has supported this view, with his introduction of a stencil to accelerate dysfunctional labour.

It is the Harari experience that, on occasion, neglected primigravidae arrive in hospital in late obstructed labour and obviously warrant immediate Caesarean Section or Symphysiotomy. These patients usually have a cervical dilatation of 7 cms. or more and show the classical features of obstructed labour.

In the majority of cases over the Action Line, however, it is still difficult to assess the presence and degree of disproportion. It was to these cases that Professor Philpott (1972), recognising that the functional capacity of a pelvis can be tested only by efficient labour, applied his regime of active management. An oxytocin augmented active Trial of Labour as opposed to the more negative and passive unstimulated Trial of Labour, deliberately creates strong contractions in the presence of probable disproportion, and it is only by so having done that the term "Trial of Labour" attains its full meaning. Should the uterine dysfunction be primary in type, then this will be quickly corrected. Should it be secondary to cephalopelvic disproportion, then the stimulated contractions will stage a true Trial of Labour, after which the Obstetrician can decide whether or not vaginal delivery will be possible and safe. As a result of the contractions, the outcome becomes apparent, does so many hours sooner than otherwise, and the degree of disproportion, if present, is determined.

The main feature of this regime to correct inefficient uterine action are:-

The intravenous infusion of "Syntocinon" (Oxytocin - Sandoz);

The total relief of maternal distress by continous epidural anaesthesia;

Close supervision throughout of mother and fetus.

At full dilatation, or at any time during this Oxytocic Trial, labour may have to be terminated either because of impending obstruction or fetal distress. The decision as to the delivery method will be of crucial importance and, always in the presence of fetal distress, must be made rapidly. The choice including as it does, Symphysiotomy as well as Caesarean Section or Instrumental Delivery, can be very problematical.

Caesarean Section, as well as the stigma to the tribal African woman of personal failure, carries with it the hazards of post-operative sepsis following on a prolonged labour. In addition the risk of ruptured uterus in a subsequent unsupervised labour where cephalopelvic disproportion is present, dictates that Caesarean Section must not be unnecessarily performed. At the same time, difficult and traumatic Instrumental vaginal deliveries must be avoided. Symphysiotomy can be the alternative.

In deciding on the delivery method, rules to assist the doctor are particularly required to correctly select the optimum mode of delivery for mother and infant.

OBJECTIVES OF THE STUDY

By 1972, the success of the Alert line and early referral to Hospital, (Philpott and Castle, 1972) was already evident in the Obstetric Practice among African patients in Rhodesia.

Further questions regarding the management of dysfunctional labour particularly in the African context, had to be answered.

Over a period of eighteen months, from June 1972, the author investigated cephalopelvic disproportion in the African primigravidae delivered in Harari Hospital, by managing and studying the events of labour.

The objectives of the study were:

(1) To determine whether the outcome of active oxytocin augmented Trial of Labour without jeopardising mother or infant, accurately reflected the degree and extent of cephalopelvic disproportion present.

To this end, exact bony pelvic dimensions were obtained by X-ray pelvimetry and compared in retrospect with the clinical outcome.

(2) To assess the response of the fetus to excessive head compression encountered in cephalopelvic disproportion and to identify the diagnostic features of the response. It seemed probable that the standard physical signs of distress from the fetus subjected to the mechanical effects of cephalopelvic disproportion, would differ from the already well documented features of hypoxia.

The fetal condition was studied in detail by analysis of the continuous fetal heart rate pattern, the pH. changes, the degree of moulding and caput, and the presence or absence of meconium.

(3) To determine which objective and quantitative clinical observations could be applied during Active Trial of Labour, to guide the Doctor working in isolation as to the duration of the Trial of Labour and to the optimum method of delivery.

In this study, these objectives were evaluated. Just as had been achieved by Professor Philpott in the recognition of the problem, so in its treatment, an attempt was here made to establish rules for the management of cephalopelvic dispeoportion in the primigravida, always within the limits of safety to mother and infant.

The findings were correlated back to the clinical level, to assist in particular, the doctor working often in isolation with African patients in the remote "Bush" hospital, to manage cephalopelvic disproportion.

Initially it was hoped to review the problem of cephalopelvic disproportion at Harari Hospital in its entirety - in the multigravidae as well as in the primigravidae. However, the response to disproportion and the problems encountered in the two separate groups, were early found to be so different that it became necessary to confine this study to the primigravidae.

Harari Hospital, the Teaching Hospital of the University of Rhodesia, Salisbury, proved ideal for such a project as this. The patients were all African in origin and belonged to the Shona Tribe.

They varied in their background. Many had recently come from the rural areas to be with their husbands and had settled in surrounding townships. Amongst them tribal customs still played an important role. Others were admitted from remote areas in the Tribal Trust lands, because of problems in pregnancy or labour.

In 1973, there were close on seventeen thousand confinements in the area served by Harari Hospital. Of these, some nine thousand took place in various maternity clinics. Eight thousand were confined in Harari Hospital itself, because of some abnormality in labour, including cephalopelvic disproportion.

Facilities of the Hospital made possible a close supervision and monitoring of labour, together with analysis of the results.

These circumstances provided a unique opportunity to investigate the problem and to translate the results gained from sophisticated techniques of measurement into guide lines for management of disproportion in the simpler Obstetric practice of the small rural Hospital.

PATIENTS AND CLINICAL METHODS

GROUPING OF PATIENTS

Two main groups of patients were looked after in labour and studied.

(1) A group of one hundred and eleven primigravidae whose cervicographic progress had crossed the Action Lines (See Introduction), thus demonstrating dysfunctional labour, was selected. Cephalopelvic disproportion was suspected in each case and only patients with no previous abnormality in pregnancy or labour were included. Thus uterine dysfunction, either primary or secondary to cephalopelvic disproportion, was the sole influencing factor. These patients were actively managed, and delivered either spontaneously, by Caesarean Section, Symphysiotomy, or Instrumentally.

(2) To establish the normal pattern of labour, a control group of twenty-nine almost consecutive African primigravid patients in labour were selected. They were normal in all respects, with a cervical dilatation to the left of the Alert Line, and had achieved spontaneous vaginal delivery within thirty minutes of organised bearing down in the second stage. These patients all conformed to the description by Crawford, (1962), of the "Clinically acceptable ideal case":-

1. The maternal age was less than thirty-five.
2. There had been no medical or obstetric disorders which could adversely be considered to have affected placental function.
3. The gestation was between thirty-eight and forty-one weeks.
4. The cervimetric pattern was reflective of normal parturition.
5. Each fetus was a singleton cephalic presentation.
6. No infant was born with any form of cord entanglement.

A further group of patients was selected in retrospect and scrutinised. These patients belonged to the "high hypoxic risk" category, where the fetus had demonstrated hypoxia in labour, by a low pH or low Apgar at birth and where cephalopelvic disproportion had been excluded on clinical grounds. These cases were all thoroughly monitored, and provided a continuous fetal heart rate pattern and pH changes, against which to compare those of the dysfunctional and control groups.

PLATE 6. The Intensive Care Unit.

CLINICAL ROUTINES AND MANAGEMENT

Each patient was looked after individually by the author, and was monitored clinically, electronically and biochemically.

Intra-partum pelvimetry was first carried out, and the patient then moved to the Intensive Care Unit, from the general Labour Ward (Plate 6).

In all cases the graphic method of recording labour was followed (Philpott, 1973) (Plate 4).

The patient was monitored clinically and by using the Hewlett Packard Cartiotocograph and fetal blood sampling. An epidural was inserted and an augmentation Oxytocin infusion set up to institute the Trial of Labour. The regime was continued for up to six hours, depending on whether or not fetal distress supervened.

If there was fetal distress, immediate delivery was indicated.

Cephalopelvic disproportion was assumed to be present:-

(a) where there was minimal progress in cervical dilation after six hours of strong contractions;

(b) where there was cervical dilatation but with a continuing high head with increasing moulding;

(c) a combination of (a) and (b).

Delivery at the appropriate time was either spontaneous, by Vacuum Extraction, or Forceps Delivery, by Symphysiotomy and Vacuum Extraction, or by lower segment Caesarean Section.

Following delivery the cord pHs. were assessed and the baby weighed. In addition, to assess in retrospect the clinical accuracy of moulding, the biparietal diameter and sub-occipito bregmatic diameters were calculated using Engineer's Calipers. (Plate 7).

Further pelvimetries, if necessary, were taken on the mother post-partum, in a number of cases.

In the control group, normal labour was monitored. Epidural analgesia and intravenous Oxytocin augmentation, were not used.

PLATE 7. Caliper measurement of the infant head.

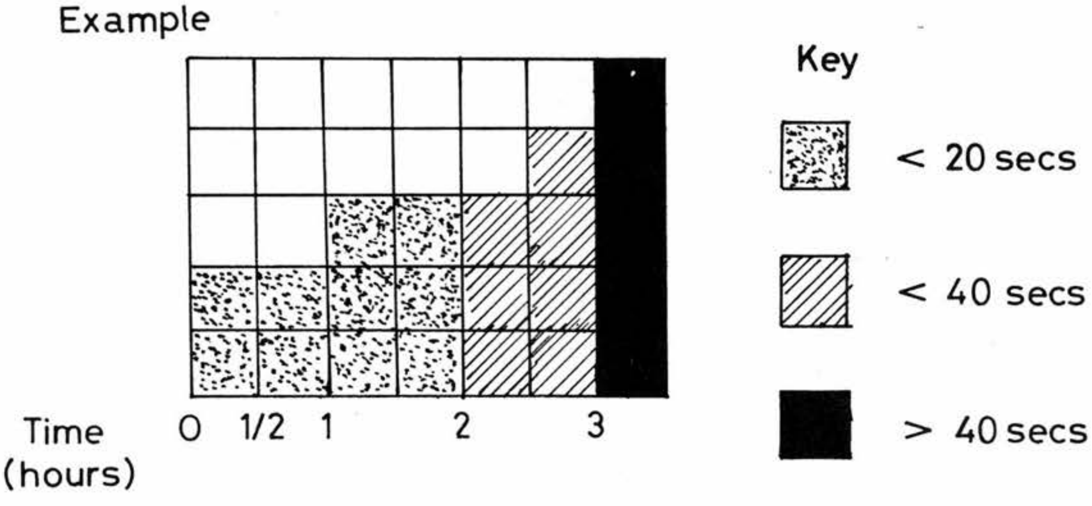


PLATE 8. Recording of Uterine Contractions.

PROCEDURES

ROUTINE CLINICAL MANAGEMENT

All patients on admission in labour to Harari Hospital were given an enema, followed by a bath. The lower abdomen was shaved.

Clerking paid particular attention to the patient's height, age, parity, the gestation of her pregnancy, and the presence of any prior ante-natal abnormality. The duration of labour and, if no longer intact, the duration of ruptured membranes at time of admission were established (patients were regarded as having been in labour if contractions had been occurring at the frequency of one in ten minutes or more.)

As few of the patients spoke English, the nursing staff proved very necessary and helpful interpreters!

General, abdominal, and pelvic examinations were carried out on all patients on admission, and thereafter as a routine four-hourly. After the Alert Line had been crossed (which in many cases had been charted, with the patient in an outlying clinic, before transfer) abdominal and pelvic examinations were performed two-hourly or more frequently if required.

After crossing the action line, the patients were transferred to the Harari Obstetric Intensive Care Unit - a three-bedded room (plate 6) fully equipped to meet allemergency contingencies and containing the apparatus necessary to monitor mother and fetus, including the pH machine.

During the subsequent Trial of Labour, the patients were fasted, all received an intravenous infusion of 5% Dextrose and were rehydrated. Blood was cross-matched to cover possible operative delivery.

Where necessary, the bladder was catheterised.

In situations where the membranes had been ruptured for greater than twelve hours, or the patients were pyrexial, penicillin and streptomycin were prescribed. At all times the patients were encouraged to lie in the lateral position.

The following procedures will be described in turn:-

General observations in labour;
Graphic recording of labour;
Radiological pelvimetry;

'Procedures' in Active Trial of Labour;
Monitoring of labour;
Methods of delivery;
Assessment of the newborn.

General Observations

The maternal pulse and blood pressure were recorded hourly, the temperature three-hourly, and the volume and constituents of urine passed noted.

Abdominal Examination

An assessment by the attendant was made for ten minutes in every half-hour, or more often if indicated.

The frequency and duration of the uterine contractions were noted, following the method described by Eskes (1962), (Plate 8).

The fetal heart rate pattern was recorded before, during, and after the contractions, using where necessary the Doptone. Day et al (1968) showed that an abnormal fetal heart rate pattern can be detected clinically by counting the rate every thirty seconds through a contraction.

Particular attention to the head level was paid at the time of vaginal examination to assess cervical dilatation (see below). The level of the head was established abdominally by palpation using Crichton's method and checked by Notelowitz's method. Crichton (1952) gauged head level by subjective comparison with the card as displayed in plate 9. Notelowitz (1973) as in plate 10 assessed the level more objectively by the number of fingerbreadths of fetal head palpable above the anterior pelvic brim.

Pelvic Examination

Thorough aseptic technique was adhered to, and the details listed below noted, the examination on each occasion, to standardise the findings, being carried out during a contraction.

The Cervix

The dilatation of the cervix in centimetres - Examination was made always during a contraction and the dilatation confirmed against a "dilatation card" (Plate 11).

The degree of effacement, closeness of application to the fetal head and the degree of cervical oedema if present, were noted.

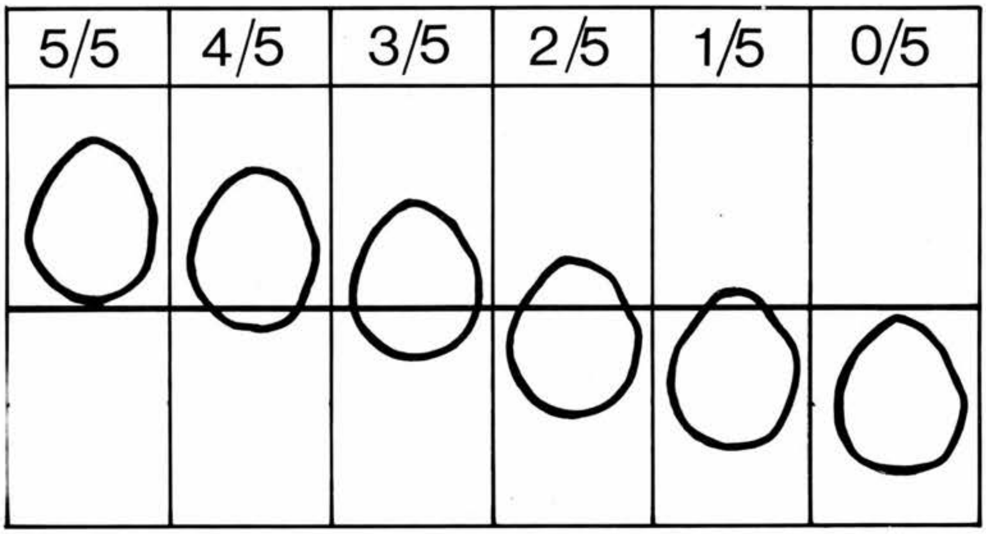


PLATE 9. Estimation of Head Level, (Crichton).

PLATE 10. Estimation of Head Level.

The Vertex.

The position of the vertex and degree of flexion - these were noted in graphic form (viz. represented vertex, left right occipito anterior; well-flexed; represented right occipito lateral; poorly flexed).

The level of the head, as determined by abdominal examination, was confirmed.

Caput

This could only be subjectively assessed, although always by the same observer. It was described in three degrees:-

- \- Equivalent to "absent"
- \+ Equivalent to "moderate"
- ++ Equivalent to "marked"

The nature of the caput whether cervical and delineated by the cervix, or pelvic and delineated by the pelvic brim, was noted.

Moulding

Moulding was scored in four degrees and described as shown in Fig. 1.

Liquor

The state of the liquor whether clear (C) or meconium stained (M) was documented.

PLATE 11. Delivery room, Wedza R. C. Mission Hospital, Rhodesia. Dilatation card and Doptone Fetal Heart Detector seen above bed.

GRAPHIC RECORDING OF LABOUR

The partograph (Plate 12) measuring 25 x 40 centimetres, formed the double-page spread of the middle of the maternity case record pages. It was attached to a clip-board at the foot of the patient's bed.

Time of entry to hospital was taken as zero time, the patient's estimate of duration of labour and ruptured membranes, however, being noted. The readings were recorded every half-hour, after a ten-minute observation of the patient.

Components of the Partogram (Plate 12)

Fetal Heart Rate

The fetal heart rate changes were graded as shown in Fig. 2. (p113)

Liquor

With the membranes intact, "I" was recorded, and if the liquor was clear, "C", or if meconium stained, "M".

Moulding

Moulding was recorded in the manner already detailed.

Cervicograph

The cervical dilatation in centimetres was assessed and a cross (X) marked at the appropriate 3 to 10 centimetres level.

The Level of the Head

The level of the head in fifths, palpable abdominally, was recorded as an open circle (O) in the "descent" portion of the cervicograph on the lines zero to five. As already demonstrated, the position and degree of head flexion could be then graphically portrayed by drawing the suture lines within the circle.

Contractions

The contractions were plotted according to Plate 8.

Drugs and Intravenous Fluids

These were recorded in the space provided.

Oxytocic Stimulation

When Oxytocin was used, the number of units in a litre and the drip rate per minute were entered.

Maternal pulse, blood pressure and temperature, urine volume and constituents, were recorded as shown.

DEGREE OF MOULDING	CLINICAL FINDINGS
-	Bones normally separated.
+	Suture lines closed. No overlap.
++	Overlap of Suture lines. Reducible.
+++	Overlap of Suture lines. Irreducible

+ s at the PO & PP suture lines are added together to provide a moulding score

FIGURE 1. Description of Moulding.

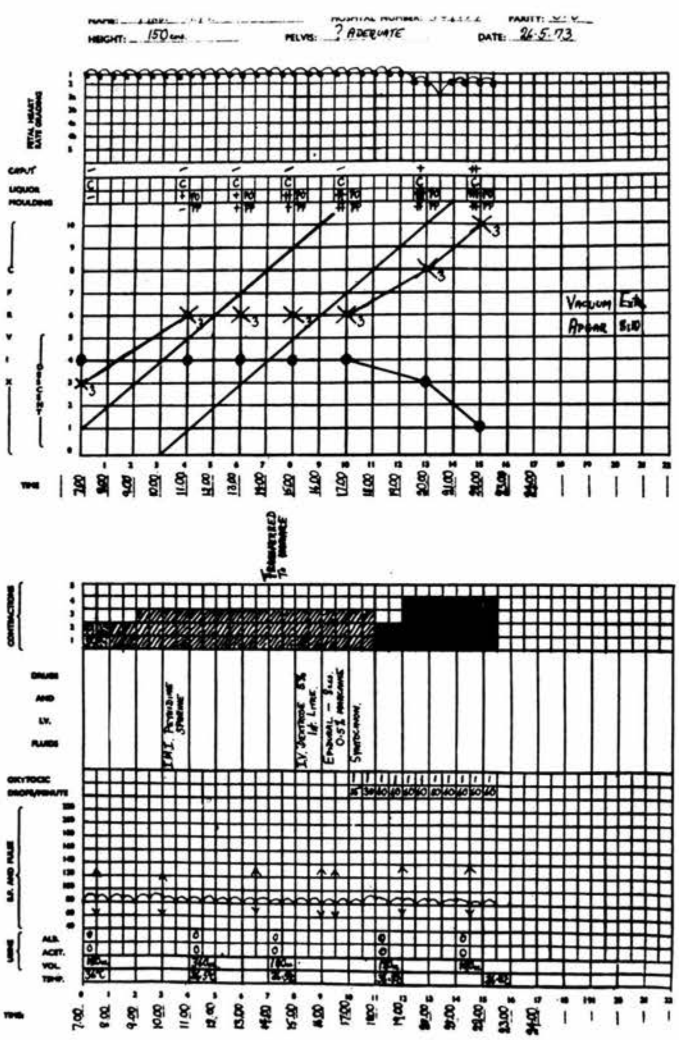


PLATE 12. The Partogram.

RADIOLOGICAL PELVIMETRY

X-ray Method

Rather than expose the fetus to excessive radiation, only two radiographs were taken in labour - an antero-posterior pelvimetry using the "tube-shift" technique, and a lateral pelvimetry which incorporated an isometric scale. Post-partum, one further film of the outlet was taken.

1. Antero Posterior Pelvimetry - the method of Murray (1971) was followed in principle, so that separate projections of the pelvic side walls were obtained on a single film by a tube shift technique, thus protecting the fetus from excessive irradiation. However, two modifications were incorporated into the method. The tube shift was made to be 5.5 centimetres rather than 5 centimetres to each side of the patient's midline. The check markers were then 11 centimetres apart - see Plate 13, 11 centimetres rather than 10 centimetres being considered closer to the true diameters involved. Thus, unnecessary distortion was avoided. Secondly, the x-ray plate, where necessary protected in a plastic bag, was placed directly beneath the patient, and not in a Potter Bucky tray. This reduced both the irradiation and also the distance of the plate from the brim inlet and ischial spines, thus rendering distortion negligible and correction factors unnecessary.
2. Lateral Pelvimetry - A true lateral x-ray of the pelvis was taken with the patient on her side - this being preferred to the more usual erect position, in view of greater comfort to the labouring patient and facility to the radiographer. A centimetre holed metal ruler was placed as in the method described by Moir (1946), between the patient's thighs, to coincide with the pelvic mid-plane. The centimetre scale equally magnified with the pelvis in the sagittal plane was thus impressed on the resulting film (Plate 14).
3. The Outlet - The outlet was viewed by the Chassard Lapine technique as described by Van Herrick and Good (1950), the patient assuming the required squatting position on the cassette and bending well forward. The pubic arch was thus made to lie approximately parallel to the film and distortion almost eliminated (Plate 15).

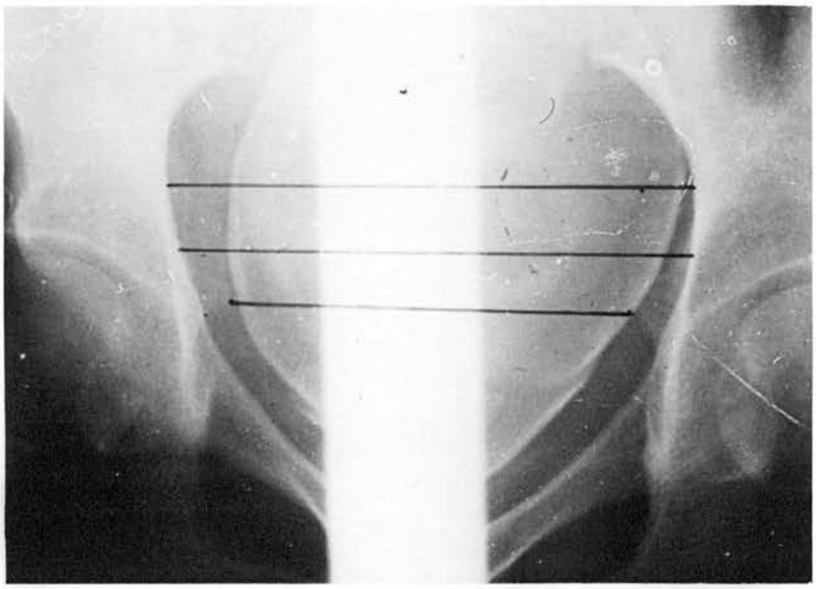


PLATE 13.

Antero - posterior pelvimetry view using Tube Shift technique.

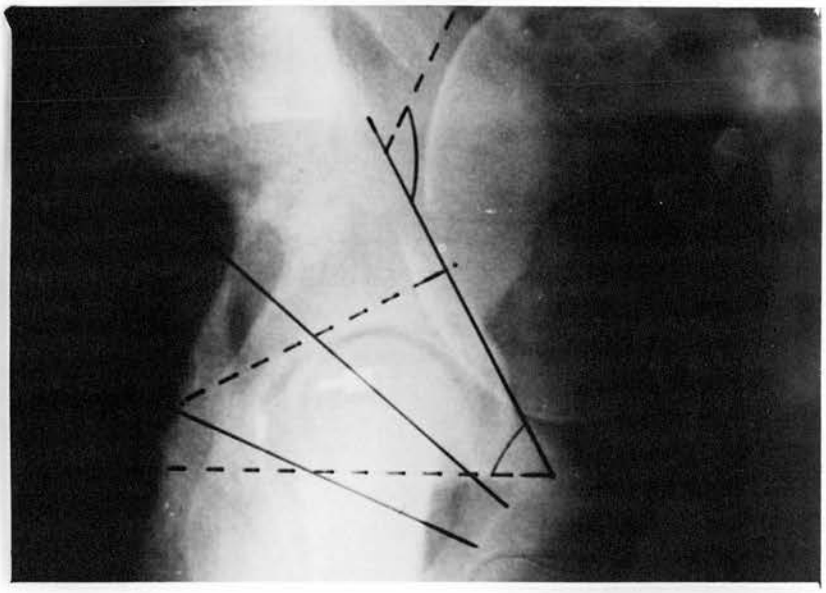


PLATE 14.

Lateral Pelvimetry View.

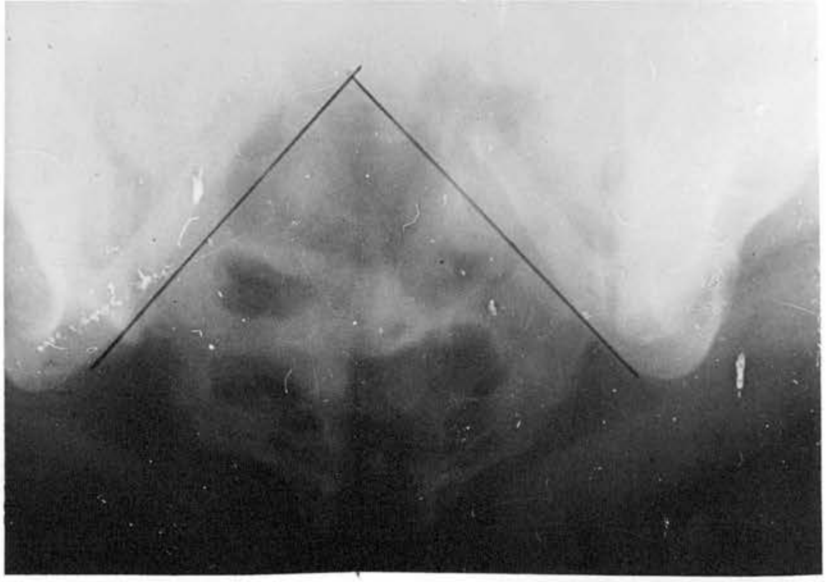


PLATE 15.

Outlet view.

PROCEDURES IN ACTIVE TRIAL OF LABOUR

Artificial Rupture of Membranes

The forewaters, if intact, were ruptured in the routine fashion, using amniotomy forceps, on all patients, once the cervix was three centimetres dilated.

Lumbar Epidural Block

Precautions - An intravenous infusion of 5% Dextrose was first set up and the circulation "preloaded" with 500 c.c. run in quickly.

The Boyle's anaesthetic machine was always checked and a laryngoscope and endotracheal tube made available.

Equipment - The following items of equipment were used:-

a 16 S.W.G. Tuohy needle,
a 20 c.c. glass syringe,
a disposable polythene epidural cannula, and
a 10 c.c. syringe loaded with 1% Lignocaine to anaesthetise the skin.

Technique - Following the routine of Crawford (1972), the patient was flexed, in the left lateral position, and the lumbar skin cleansed and draped. The L2 and 3 intervertebral space was identified and the skin anaesthetised with 1% Lignocaine. The Tuohy needle with stylette was then inserted and gently advanced, between contractions, through the spinous ligaments. The stylette was removed, and the empty glass syringe with plunger withdrawn, attached to the needle. Resistance to digital pressure on the plunger was noted. With further advance, the needle entered the epidural space, recognised by the loss of resistance and the free passage of air from the syringe in to the negative pressure of the space. The syringe was disconnected and the needle observed to check that no blood or Cerebrospinal Fluid came from it. The catheter was then passed through into the epidural space, for at least a few centimetres, and the needle withdrawn. The catheter was first checked, again to exclude blood or Cerebrospinal Fluid, and then taped to the patient's back, its external end being brought up and fixed to the right shoulder.

<u>Complications</u> - In the presence of leaking blood or Cerebrospinal Fluid, the Tuohy needle or catheter was withdrawn and the attempt to enter the epidural space repeated, at the intervertebral level L1 - 2.

<u>Test Dose</u> - The patient's blood pressure was first recorded. A test dose of 3 c.c. of 0.5% Lignocaine was injected through the needle, and two minutes later the blood pressure was again checked. The patient was requested to move her toes and asked if she had noticed a strange taste. All being well, the "loading dose" was proceeded to.

<u>Loading dose</u> - "Marcaine" (Bupivicaine Hydrochloride) 0.5% plain, was used, 2 c.c. being inserted every two minutes, to a total of 8 c.c. After each 2 c.c. injection, the "test dose" checks were repeated.

Following completion of the "loading dose", the patient was directed to lie on alternate sides every three to four minutes, over the subsequent twenty minutes. Her pulse and blood pressure were recorded at five-minute intervals over this time, and thereafter half-hourly, unless more frequent observations were indicated.

Finally, the efficacy of the anaesthetic and the dermatome involvement of the skin was checked, using needle pricks.

<u>"Topping up Doses"</u> - When the patient reported discomfort or required analgesia for instrumental vaginal delivery or Caesarean Section, a further 8 to 10 c.c. 0.5% plain Marcaine was instilled, the procedures as for the "loading dose" being repeated. Where vaginal delivery was anticipated, the patient was sat up, to achieve perineal anaesthesia.

<u>"Syntocinon" (Oxytocin - Sandoz) Intravenous Infusion</u> - "Syntocinon" was administered according to the titration regime described by Turnbull

and Anderson (1968) the resulting contractions being used to determine the dose of Syntocinon infused.

A 5% Dextrose infusion was set up and then changed to "Syntocinon" in 1,000 c.c. of 5% Dextrose, and the dose increased quarter-hourly, as described below, until regular contractions lasting up to forty seconds and occurring three to four times in ten minutes were obtained.

Units of Syntocinon in 1 Litre of 5% Dextrose	Drip Speed in Drops per Minute (milliunits/minute in Parenthesis)		
1	15(1)	30(2)	60(4)
4	15(4)	30(8)	60(16)
16	15(16)	30(32)	60(64)

To improve the safety and accuracy of delivery and to ease the work of the nursing staff, an Ivac Model 501 Infusion Pump (Plate 6) was used, with a giving set geared to release 1 c.c. of fluid in fifteen drops.

The infusion was continued for the duration of labour, the dose being based on uterine response, and for one hour after completion of the third stage.

MONITORING OF LABOUR

Fetal Monitoring - Plate 16 displays the equipment used to monitor the fetus.

The fetal heart rate and the uterine contractions were recorded using the Hewlett Packard Cardiotocograph Machine (Model No.HP8020A).

In all cases, the fetal heart rate was obtained by direct monitoring via an electrode attached to the fetal scalp. Because of insuperable difficulties in acquiring equipment, a "home-made" monopolar scalp electrode was devised. (Plates 17 and 18) This was corkscrew in type, the spirals being made from stainless steel wire plated with ~~silva~~ silver chloride, and set into a perspex barrel of dimensions 1 x 1½ cm. This barrel was grasped in a modified intestinal clamp and the electrode applied by a 90^{o} clockwise rotation of the barrel held firmly against the fetal scalp. The advantages of this spiral electrode over the standard Michelø clip, were that

(1) it could be inserted by touch through, if necessary, a minimally dilated cervix;

(2) it could be inserted without prior amnioscopy;

and (3) it proved much more reliable with a lesser tendency to be dislodged at subsequent vaginal examination.

To measure uterine activity, where possible, a transcervical intrauterine catheter was inserted to provide a quantitative measure of intrauterine pressure . In the early stages of this investigation, the commercial catheters available were found to be of too thin a bore and, apart from clogging with, e.g. meconium and vernix, also collapsed under the bone to bone pressure present in the cephalopelvic disproportion situation. Of necessity, on occasions, therefore, extrauterine tocography had to be used. Subsequently, much more satisfactory results were obtained using a Portex polythene cannula 2 metres long and of calibre 0.5 cms.

The cannula was open ended with six holes of 2 mms. diameter cut through the wall of the cannula over the last 10 cms., with a hot fifteen gauge needle. The proximal end was fitted on to a shortened fifteen gauge luer fitting needle, and this, in turn, was attached to a three-way tap and thence to an external Statham transducer incorporated in the Hewlett Packard Cardiotocograph system. This transducer measured true intrauterine pressures, being electrically calibrated as specified by the manufacturers. The calibration could be changed to give a reading of either 10 or 20 mm. Hg. pressure per division on the graph.

A three-way tap was connected to the dome of the pressure transducer, the intrauterine cannula being connected to one outlet, as mentioned above, and the other outlet to a vacolitre of saline, so that the cannula could be copiously flushed without the risk of exposing the sensitive pressure membrane to a damaging pressure head. The use of syringes for flushing, as recommended by the manufacturers, was avoided.

The cannula was inserted directly into the uterus through the cervix. Because of perforation dangers inherent in the use of the applicator, this was not used and was, in any case, found to be unnecessary.

A permanent paper copy display of the fetal heart rate/uterine contraction pattern was produced by the Hewlett Packard machine on a strip chart (Plate 16) run through at 1 cm. per minute.

<u>Fetal Blood Sampling</u> - Fetal blood sampling, to establish the fetal pH, was taken at time of admission to the Intensive Care Unit, and thereafter, only in the presence of fetal heart rate abnormality or excessive head compression, before finally, prior to delivery. Fetal blood sampling was repeated half-hourly if below 7.25 and immediately if below 7.20.

The technique used for the collection of fetal blood was essentially that described by Morris and Beard (1965), blood being obtained from the skin overlying the fetal skull. A conical endoscope (Plate 17) was introduced through the cervix until it was firmly against the fetus. A small area of fetal skin could then be visualised and isolated from surrounding debris and amniotic fluid. The skin was cleaned with a cotton-wool dental swab, sprayed with ethyl chloride to produce reflex hyperaemia, and covered with a thin film of silicone gel to allow the blood to form discrete globules.

A small incision was made in the fetal scalp using an Opthalmic Beaver blade No. 62 held in a modified 10" intestinal clamp, the modification being a pin set into the jaws of the clamp to fit through a hole in the Beaver blade and into a corresponding hole in the adjacent jaw of the clamp, thus presetting and controlling the depth of penetration of the blade into the fetal scalp, to 2.5 mms. The blood was collected into R.G. 168 angled glass tapered heparinised tubes, manufactured by London. To economise, and because of shortage of equipment, the used tubes were cleaned and reheparinised locally. These proved perfectly satisfactory.

The pH. of the fetal blood sampling was obtained using a Vitalograph Combi Analysator (Plate 6), adapted to take the Pye micro capillary pH. electrode system (135N/335/N/945). This apparatus proved to have much better control in handling the often minimal volumes of blood available from scalp sampling as compared with the better known Astrup machine.

In the majority of cases, all fetal blood sampling was taken in the lateral position, thus causing the patient only minimal disturbance, saving effort on the part of the attendants, and facilitating continuous monitoring.

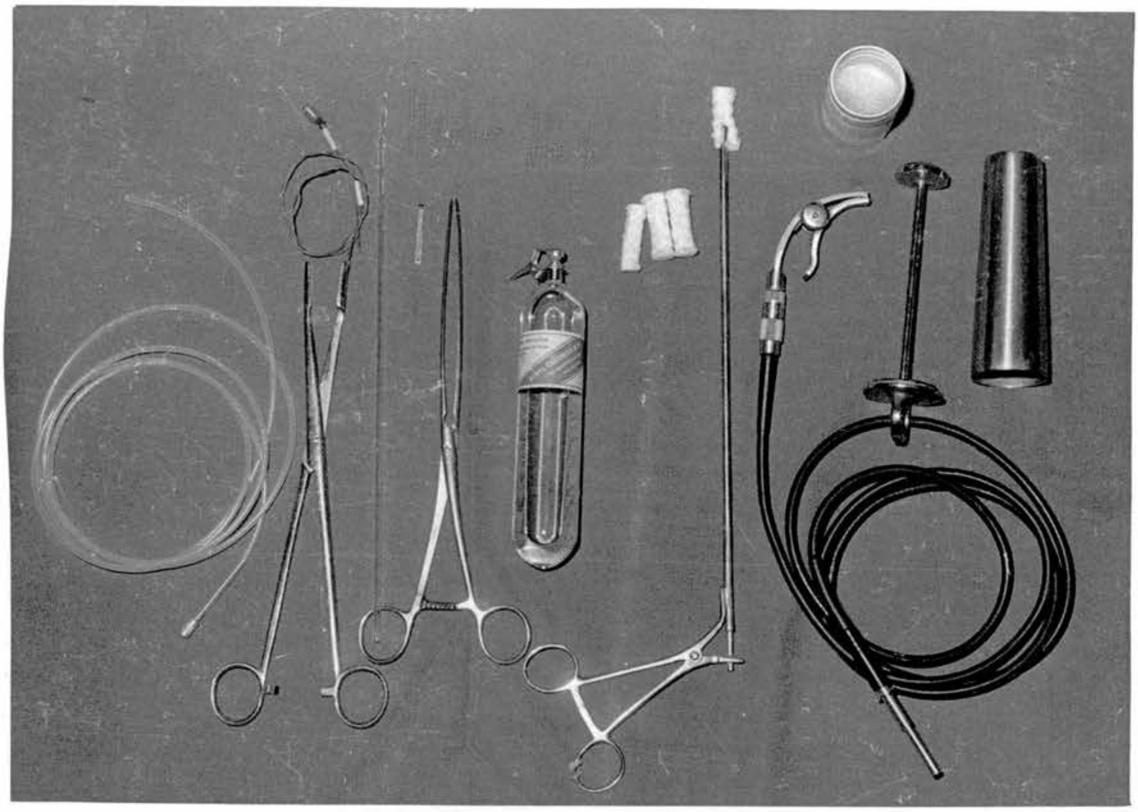


PLATE 17. Instruments used in monitoring.

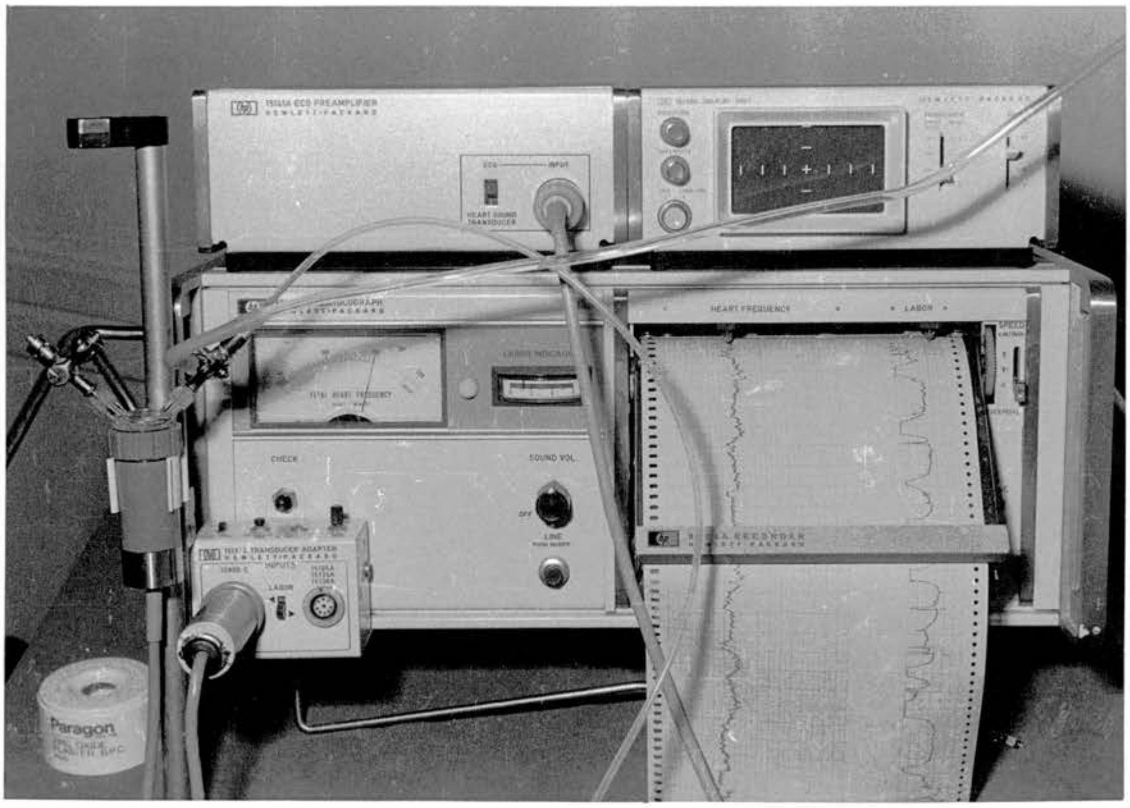


PLATE 16. The Hewlett Packard cardiotocograph.

PLATE 18. Corkscrew scalp electrode in position.

METHOD OF DELIVERY

The timing and mode of delivery were determined by the dilatation of the cervix, the presence or absence of fetal distress, the level of the head, and the degree of moulding. These features will be later discussed.

The rules and techniques used in the alternative methods of delivery are presented below.

Spontaneous Vaginal Delivery

Where there was no fetal or maternal distress, then at full dilatation, the mother was encouraged to bear down for a supervised period of up to thirty minutes. The fetal heart was auscultated between every contraction. If fetal distress occurred, or, if the patient were undelivered after thirty minutes of organised pushing, assisted delivery had become indicated.

Vacuum Extraction

Before applying the vacuum cup, the cervix had to be fully dilated, and the exact position of the head known. Strong contractions were mandatory.

Because of risk of infection, the bladder was catheterised only when it was palpably full and episiotomy was carried out in the presence of perineal over-distension.

Procedure - The usual aseptic precautions were taken. The 5 cm. cup was used in most cases and was placed as far back over the occiput as possible. A vacuum of 0.2 kg. per sq. cm. was first created and then careful vaginal examination carried out to confirm that no maternal tissue was caught in the cup. The maximum vacuum possible was then obtained, and traction applied so as to flex the head. The thumb of the non pulling hand was used to prevent the cup from slipping off, while the index finger of the same hand monitored the descent of the head. Traction perpendicular to the cup was applied synchronously with the uterine contractions. There was strict adherence to a rule of four pulls:-

First pull - must dislodge the head by flexion

Second and third pulls - the head must descend to the pelvic floor

Fourth pull - should lead to delivery or imminent delivery.

Should progress not be shown with each pull, then an alternative method of delivery - i.e. either Symphysiotomy, or Caesarean Section - had become indicated.

Symphysiotomy -

The patient was placed in the lithotomy position and the legs were supported by two assistants to limit the angle of abduction of the thighs to eighty degrees. 5 ml. of 1.0% Lignocaine was injected into the skin over and around the symphysis pubis and the perineum was infiltrated. A firm Jacques No. 6 catheter was then passed into the bladder. The two fingers of the left hand were inserted into the vagina to displace the urethra wall laterally and so protect the urinary tract and vagina from damage. Using a solid bladed Bistoury knife (Glaxo Allenbury No. 14554), the scalpel was inserted through a ¼" incision in the skin over the centre of the joint. The fibro cartilage was incised completely, exactly in the mid-line from above downwards. Inferiorly the arcuate ligament was also incised at the inferior border of the joint. During the procedure, the knife could be felt impinging on the vaginal fingers, thus determining that the full depth of the cartilage had been cut. Any haemorrhage was controlled by direct pressure.

As it was important that the fetal head alone should determine the degree of separation of the symphysis, once the incision had been made, the assistants brought the legs together in adduction.

An increase of about 2.5 cm. (a thumb's breadth) in separation was usual.

A liberal episiotomy was absolutely essential, so that the head could be delivered far posteriorly, well away from the no longer protected urethra and bladder.

Routinely the vacuum extractor was applied to accomplish final delivery, not so much to apply traction, as to guide the head posteriorly away from the anterior vaginal wall. The more that the mother was able to efficiently bear down, the less traumatic traction was necessary.

Following delivery of the anterior shoulder, 0.5 mg. intravenous ergometrine was infused and the oxytocinon was kept running for a further hour. The episiotomy was repaired and one skin suture inserted over the symphysis. An indwelling foley bladder catheter was inserted and the knees tied together.

<u>Post Operative Care</u>

The knees were held together over the first two days and the patient nursed on her side. Continuous catheter drainage was continued for five days and prophylactic antibiotics prescribed.

On the fifth day the patient was started walking, assisted with two rubber tipped sticks. On the tenth day she walked without sticks and on the fourteenth day, all being well, she was discharged home.

<u>Caesarean Section</u>

<u>Anaesthesia</u> - In all cases, the epidural analgesia, inserted during the first stage of labour, was used to provide the analgesia for Caesarean Section. This was satisfactory in most instances. Prior to operation, Kocher's forceps were applied to the skin to check that the analgesia was adequate. In a few cases, further local skin infiltration with local anaesthetic was necessary. A further few patients, complaining

of discomfort were given intravenous "Ketalar" (DL 2 chlorophenyl, 2 methyl amino cyclohexanone hydrochloride - Parker Davies) and "Valium" (Diazepam - Roche).

During the operative procedure, the patient was prevented from seeing the surgeon or the operation site by means of a screen. She was spoken to by a nurse and reassured throughout. Pulse, blood pressure were recorded at five minute intervals.

<u>Technique of Caesarean Section</u> - The routine procedure was followed. In all cases, Caesarean Section was by transverse lower segment incision.

ASSESSMENT AND MEASUREMENT OF THE NEW BORN

At birth the cord was promptly doubly clamped and blood obtained from the umbilical vein and artery for pH estimations.

All infants were scored at 1 and 5 minutes by Apgar (Apgar 1953). The baby and placenta were weighed.

To quantitate in retrospect, the degree of moulding, the biparietal and sub-occipital bregmatic diameters of the skull were measured immediately following birth, by lightly grasping the head from side to side and measuring with engineer's calipers (Plate 7), the span then being read off on a ruler. Five days after birth, by which time in all cases, the moulding and caput had subsided, the measurements were repeated. From the biparietal and sub-occipital bregmatic diameters, the presenting area of the well flexed head was calculated from the formula $\pi \times \frac{BPD}{2} \times \frac{SOB}{2}$ The difference in head areas between days five and one, was then calculated to produce an objective measurement of reduction in head area caused by the moulding.

The difference in mento-vertico diameter from days one to five produced a measurement of the degree of moulding and caput formation.

Finally, the general condition of the baby was noted at time of discharge.

RESULTS

CLINICAL GROUPING

Each case which had crossed the Action Line, (Page 35) was analysed in retrospect, following delivery. If any abnormality in labour in addition to possible cephalopelvic disproportion had developed, to influence the outcome and mode of delivery, that case was set aside. A separate group of twenty-nine patients was thus first extracted from the total series. In these cases, as shown in Table 1, complications such as cord problems, intra uterine infections and placental insufficiency were present and had influenced the timing and mode of delivery.

From the remaining cases, where uterine dysfunction and possible cephalopelvic disproportion had been the sole complication, three groups were created. The mode of delivery (Table 2) was used to define whether the degree of disproportion had been major, minor or absent. If delivered operatively by Caesarean Section or Symphysiotomy, the cephalopelvic disproportion was deemed to have been major. If delivered instrumentally by the vaginal route, minor cephalopelvic disproportion was present. Rapid progress in labour following Oxytocic infusion and leading to a spontaneous vaginal delivery, with no clinical evidence of disproportion suggested primary uterine dysfunction in the absence of cephalopelvic disproportion.

For purposes of comparison throughout, the control group provided an indication of normal values. Table 3 shows the total number of cases in each group.

TABLE I

FACTORS ADDITIONAL TO DYSFUNCTIONAL LABOUR (29 cases)

Cord Complications	17
Intrauterine Infection	6
Probable Placental Insuffiency	3
Uterine Hypertonus	2
Intra-partum Haemorrhage	1

TABLE 2

MODE OF DELIVERY

MODE OF DELIVERY	DEGREE OF CEPHALO-PELVIC DISPROPORTION PRESENT
Surgical: Caesarian Section / Symphysiotomy	Major
Instrumental: Vacuum Extraction / Forceps Delivery	Minor
Spontaneous, without evidence of cephalo-pelvic disproportion in augmented labour.	Absent. Primary Uterine Dysfunction present.

TABLE 3

TOTAL NUMBER OF CASES IN EACH GROUP

Major cephalo-pelvic disproportion	50
Minor cephalo-pelvic disproportion	21
Primary Uterine Dysfunction	11
Uterine Dysfunction + Other complications	29
Control Group	29

ADDITIONAL COMPLICATIONS IN DYSFUNCTIONAL LABOUR

Table 4 presents the twenty-nine cases where the uterine dysfunction was further complicated by other factors. In twenty-five of these cases from the various criteria later described, a degree of cephalopelvic disproportion was considered to be present.

Out of the total series therefore, a high percentage of cases with cephalopelvic disproportion developed additional complications. Table 4 shows that cord involvement and intra uterine infection were the chief complicating factors and that in 50% of the cases, these factors cut short a true Oxytocic Trial of Labour and determined the timing and mode of delivery.

The complications are discussed in turn.

CORD COMPLICATIONS.

Where at delivery, the cord was found to be compressed either across the shoulder or around the neck, the case was regarded as complicated and was extracted from the general series. Cord complications occurred in seventeen cases out of the total of one hundred and eleven, representing a 15% incidence.

Compared to the occurrences of nuchal cord reported from general population groups by Sinnathuray (1966), Kan and Eastman (1957), Horwitz, (1964), Dippel, (1964) and Crawford (1962), the incidence found in this study was, in fact, low. The occurrence of nuchal cord in the series should not, therefore, be associated particularly with the cephalopelvic disproportion.

In no case was the cord prolapsed.

TABLE 4

COMPLICATIONS PRESENT IN THE UTERINE DYSFUNCTION GROUP (29 cases)

		Cord Complications	Intra-uterine Infection	Probable Placental Insufficiency	Uterine Hypertonus	Intra-partum Haemorrhage
Probable degree of Cephalo-pelvic Disproportion	Major	10	5	1	2	1
	Minor	4	1	1	0	0
	Nil	3	0	1	0	0
Mode of Delivery	C.Section	10	5	2	1	1
	Symphysiotomy	5	0	1	1	0
	Vacuum Extraction	2	1	0	0	0
% of Cases where Delivery affected		66	14	100	0	100
Perinatal mortality		0	0	1	0	0

INTRA UTERINE INFECTION

Intra uterine infection was diagnosed if purulent liquor was noted or if the placenta and fetus were found to be offensive at delivery.

In the cases described, there had been no evidence of intra uterine infection, prior to insertion of the intra uterine catheter, although in six of the seven patients, Penicillin and Streptomycin were prescribed prophylactically because the membranes had been ruptured for more than twelve hours. In two patients, B. coli was isolated from bacteriological culture of a placental swab.

Where the membranes have been ruptured for a length of time which in these cases varied between eleven and thirty-eight hours, intra uterine infection will always be a potential hazard. Whether or not insertion of the intra uterine catheter further increased the risk, is debatable. Charles (1973) claimed that there should be only a very low incidence of intra uterine infection following catheterisation. He is supported in this view by Chan et al (1973).

PLACENTAL INSUFFICIENCY

A retrospective diagnosis of intra uterine growth retardation was made after delivery, following Paediatric assessment of the infant's birth weight and gestational maturity. Two cases were small for dates and in one of these, the infant died - the one perinatal death in the study.

CASE REPORT - NEONATAL DEATH

The patient, an unbooked nineteen years old primigravida, was admitted after having been twelve hours in labour. The cervix was 4 cms. dilated, the liquor was clear and the head was four-fifths palpable above the pelvic brim with three pluses of moulding present (Fig. 1). The fetal pH was 7.28.

After four hours of strong Oxytocin induced contractions, the cervix had dilated to only 6 cms., the pH had dropped to 7.23. A Caesarean Section had become indicated. The head level was threefifths above, and moulding score six. At birth the infant was in poor condition, covered in meconium and with cord pHs of 7.22 and 7.12. The Apgar was 1:6 and the infant weighed 2,400 gms. The placenta was heavily infarcted and weighed 350 gms. The baby, considered to be at term and small for dates became increasingly distressed on the second and third day. He died on the fourth day. Post mortem findings were of hypoxic intra-cranial haemorrhage and bronchopneumonia. There was no clear evidence of cerebral trauma.

The mother's pelvis was contracted with a brim area of 75.1 sq.cms. the antero posterior diameter of the brim being 9.2 cms. and the available transverse diameter, 10.4 cms. Despite the small size of the infant, a significant degree of cephalopelvic disproportion was considered to have been present.

In retrospect it was wrong to subject this already at risk infant to the stress of an augmented Trial of Labour. However the diagnosis of intra uterine growth retardation in labour without adequate prior ante-natel supervision can be most difficult, and in this case was missed.

In the third case, the infant, weighing 3.005 gms., was considered to be three weeks post mature. The placenta was infarcted and weighed 420 gms.

UTERINE HYPERTONUS

As described on page 62 , the oxytocic intravenous infusion was closely supervised throughout to avoid excessive uterine stimulation with an immediate reduction of the dose as required. In two cases out of the series an acceptable contraction pattern proved very difficult to achieve. The uterine contractions were excessive, fetal distress developed and continued after the Oxytocin was stopped, necessitating delivery. In each of these cases, the cephalopelvic disproportion was considered major.

Plate 19 highlights the necessity for close supervision of uterine contractions when Oxytocin is being administered and demonstrates a case where the uterus was extremely sensitive to a low dosage of Oxytocin, becoming hypertonic almost immediately following commencement of the infusion.

INTRA PARTUM HAEMORRHAGE

In one case, the intra uterine catheter filled with dark blood immediately following its introduction posteriorly into the uterine cavity. The catheter was immediately withdrawn and reinserted anteriorly. Labour was stimulated for a total of two hours, at the end of which time, because of recurring vaginal bleeding and the development of fetal hypoxia, a Caesarean Section was decided upon. At operation, the placenta was found to be low in the upper segment and posterior. A 200 cc. retro-:placental clot confirmed that placental abruption had occurred - presumably at time of catheter insertion. The condition of the infant at birth and subsequently was satisfactory.

Following this experience, the relatively rigid catheters necessary in the presence of cephalopelvic disproportion, were inserted up the lateral, rather than the anterior or posterior uterine walls, to reduce the risk of placental damage.

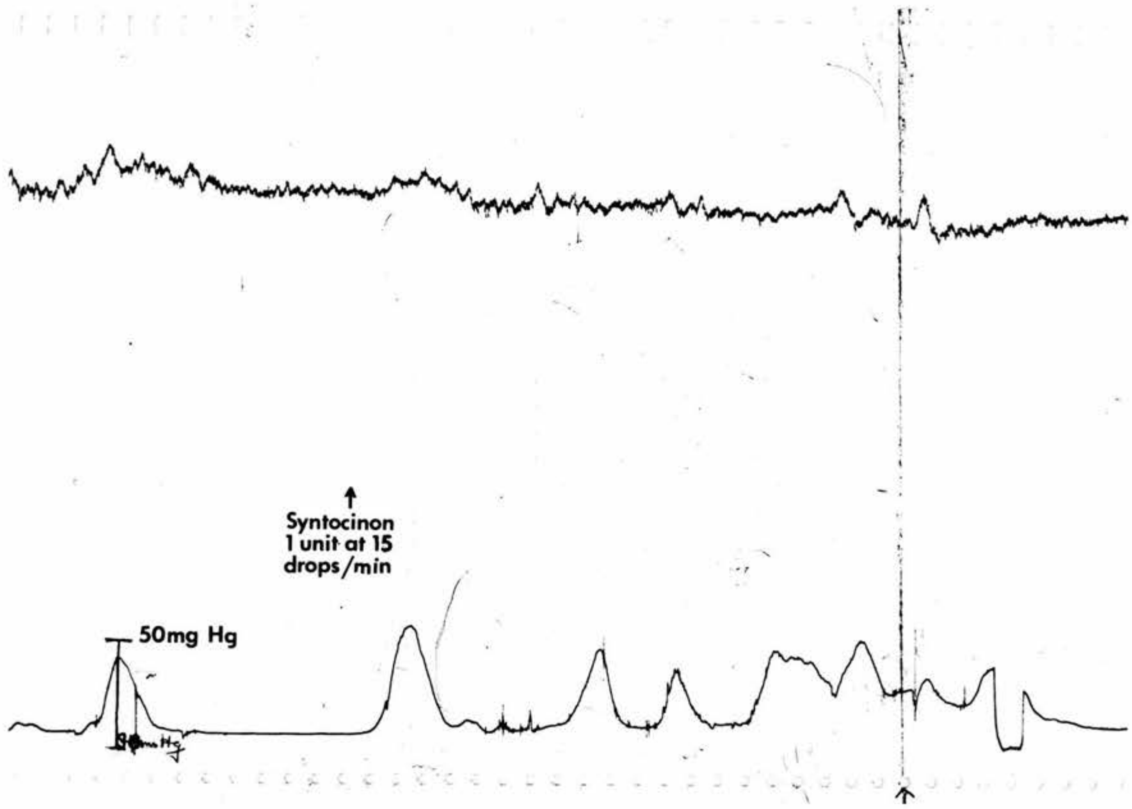


PLATE 19. Uterine contraction response to Oxytocin intravenous infusion.

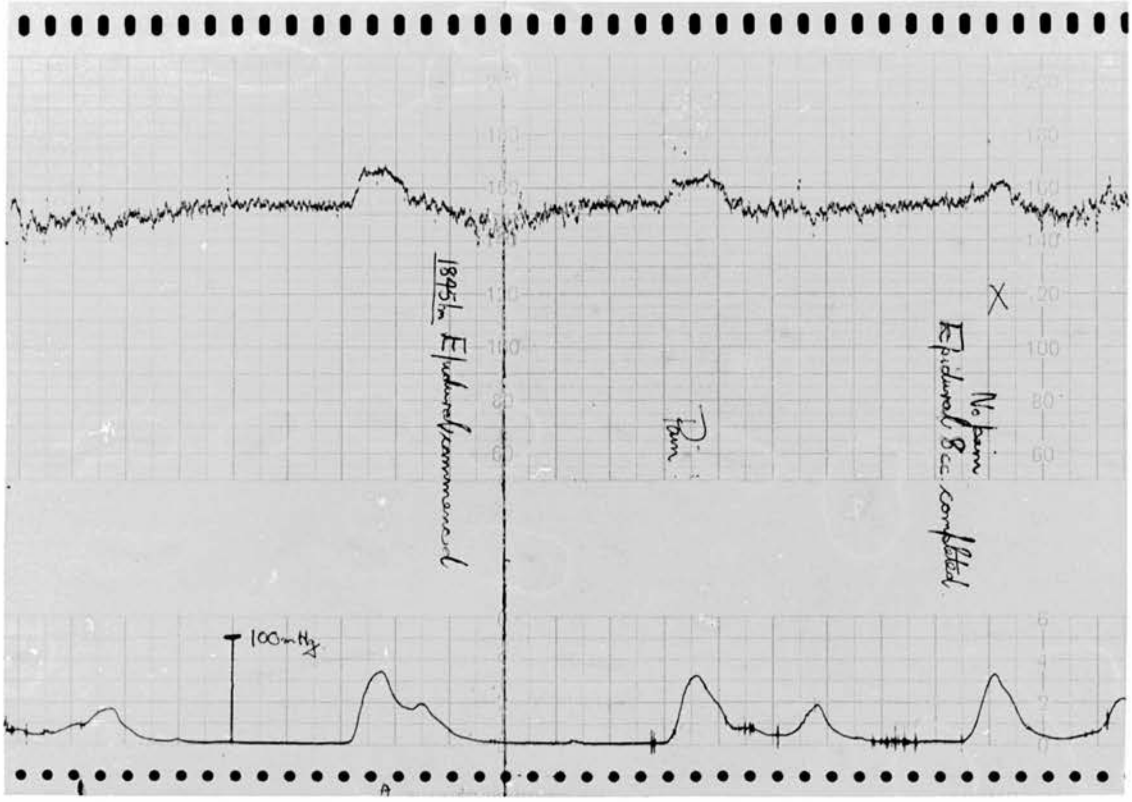


PLATE 20. Response to Epidural.

MORTALITY AND MORBIDITY

There was no maternal mortality in this study.

Perinatal mortality was zero in each of the pure dysfunctional labour groups and none of the babies showed any evidence of cerebral trauma during their stay in Hospital.

The one neonatal death which occurred, has been described. (page 79).

DURATION OF LABOUR

Table 5 shows the various mean durations of the different phases in labour.

An attempt was made to estimate the duration of labour, timing the onset from the point when the frequency of contractions had become one in ten minutes. To most of the patients questioned, however, time was unimportant and few, in fact, possessed a time-piece. Only a highly subjective estimate of the duration of labour was therefore obtained. The results showed no statistical difference in the mean duration of labour between the major, minor or pure dysfunctional labour groups. There was a significant difference, as expected, between the major and control groups ($p < \cdot 001$), the minor and control ($p < \cdot 001$) and the primary dysfunctional and control groups ($p < \cdot 01$).

A similar uncertainty obtained in assessing the duration of ruptured membranes - as in the large majority of cases, the membranes had ruptured before admission to Hospital. Again there was no significant difference statistically among the three dysfunctional labour groups, and each in turn was significantly different from the control group ($p < \cdot 001$) where the mean duration of ruptured membranes was 5.7 hours.

The duration of time from arrival in Harari Hospital to delivery proved more meaningful. The control group were in labour in Hospital for a mean of only 5.2 hours - a significantly shorter time ($p < 0 \cdot 001$) than for each of the other groups. The minor disproportion group were longer in labour in Harari, however, than the major group ($p < 0 \cdot 01$).

TABLE 5

MEAN DURATIONS IN LABOUR

	Hours in Labour	Hours in Harari Hospital	Hours with Ruptured Membranes
Major CPD (50 cases)	25.6	10.6	15.5
Minor CPD (21 cases)	25.9	14.2	16.8
Primary Uterine Dysfunction (11 cases)	22.5	12.0	14.8
Control (29 cases)	12.7	5.2	5.7

RADIOLOGICAL PELVIC DIMENSIONS AND THE OUTCOME OF TRIAL OF LABOUR

The pelvic dimensions measured radiologically, were studied to assess whether the outcome from the active Trial of Labour had accurately categorised the presence and degree of cephalopelvic disproportion. First, to ensure reliability of the equipment and to check the accuracy of the readings in the living patient, a dried bony pelvis from an adult female cadaver (Plate 21), was X-rayed, and the X-ray readings compared with the actual measurements. As shown in Table 6, the differences were negligible and the accuracy of the pelvimetry methods confirmed.

X-RAY MEASUREMENTS

The following measurements were obtained for each patient:-

(1) From the Antero Posterior View (Plate 13)

The widest transverse diameter (W.T.D.) of the brim - taken as being the maximum transverse length at the level of the arcuate lines.

The available transverse diameter (Av. T.D.) of the brim - the transverse diameter between the supra-acetabular margins.

The inter ischial spinous diameter (I.S.D.) - the distance between the tips of the spinous processes.

Special mention should be made at this point regarding the available transverse diameter of the brim. This was considered by Chassar Moir (1946) to be much more meaningful than the widest transverse diameter, the practical obstetrical significance of which was dependent on its position relative to the sacrum. He described the available transverse diameter as being the diameter which intercepts the true conjugate of the brim at its midpoint. The reason for this selection was as follows. In the round pelvis, the widest transverse diameter is situated well forward, coinciding or nearly coinciding with the available transverse diameter. In a pelvis of this shape, the fetal head can make full use of the space available at the brim. In a wedged shaped brim, however,

PLATE 21. Adult female cadaver pelvis.

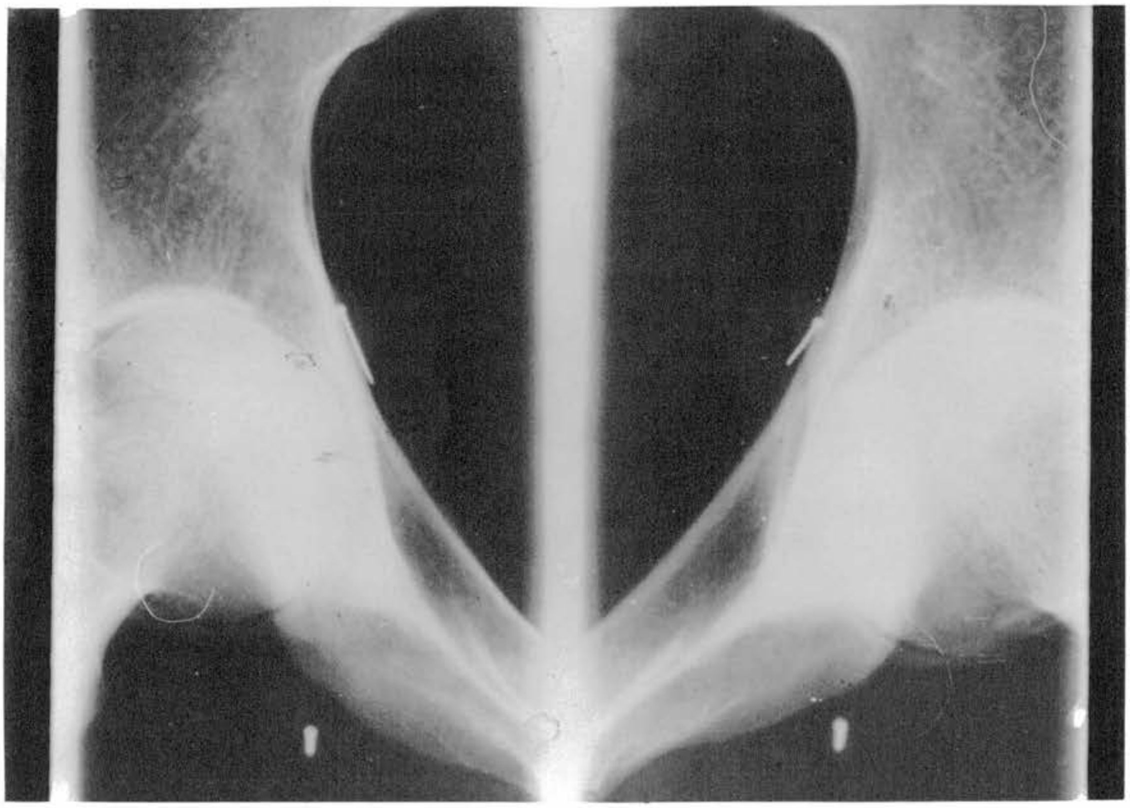


PLATE 22. X - Ray showing marker pins on cadaver pelvis side walls.

the widest transverse diameter is situated near to the sacrum and the fetal head cannot make use of the space available. The available transverse diameter in such a case is far in front of the widest transverse diameter. Measuring much less, it furnishes a better indication of the restricted obstetric value of this type of pelvis.

Chasser Moir (1946), in obtaining his available transverse diameter, had the advantage of an inlet or Thom's view, where there was no distortion. Because of the now recognised fetal irradiation hazard, however, this projection is no longer ethically acceptable and has been superceded by the much safer antero-posterior view. A method for determining this same diameter from the fore-shortened pelvic brim of the antero-posterior film had therefore to be established.

The dried bony pelvis (Plate 21), was used for this purpose. A ruler was first placed in the pelvis, to measure the antero-posterior brim diameter. The mid-point was noted and a straight edge placed across this mid-point, to touch the pelvic brim on each side. A marker pin was then cellotaped to the mid-point of the brim on each pelvic side wall and an antero-posterior projection of the pelvis taken.

As seen on <u>Plate 22</u>, the position of the markers corresponded closely with the two superior acetabular margins. The available or true antero-posterior transverse diameters described by Moir could thus be identified by and measured from a line drawn between the superior acetabular margins. This finding was confirmed using two further cadaver pelves.

In obtaining these measurements from the antero-posterior view, as already stated, no correction factor was considered necessary and the dimensions were read directly from the X-ray film.

TABLE 6

DIMENSIONS OF CADAVER PELVIS

(Adult African female)

	API	APM	APO	LS	LPS	I.Ac.D (Av.T.D)	WTD	ISD
Actual	10.6	12.4	12.2	10.3	4.2	10.5	11.2	8.8
Xray	10.5	12.5	12.4	10.2	4.1	10.4	11.4	8.7

LS - Length of sacrum
LPS - Length of pubic symphysis
I.Ac.D- Inter Acetabular Diameter(Av.T.D.)

TABLE 7

OBJECTIVE MEANS OF ASSESSING BRIM SHAPE

(based on Nicholson and Allen(1946))

Platypelloid	Brim index of 81 and under
Anthropoid	Brim Index of over 104
Android	Sagittal Index of 30 and under
Gynaecoid	Brim Index of 82 to 104 Sagittal Index of over 30

(2) From the Lateral Pelvimetry View (plate 14), were taken:-

The antero-posterior diameter of the inlet (A.P.I.) - the shortest distance between the upper and inner margins of the pubic symphysis and the nearest point of the sacrum usually the promontary itself.
The antero-posterior diameter of the mid-cavity (A.P.M.) - the distance between the mid point down the inner margin of the pubic symphysis and the junction of S2 and 3.
The antero-posterior diameter of the outlet (A.P.O.) - the distance between the tip of the sacrum and the inner lower border of the pubic symphysis.
The posterior sagittal antero-posterior diameters of the pelvic inlet (P.S.A.P.I.) - calculated by drawing in the coronal plane a perpendicular line to meet the inlet plane, passing through the ischial spines.
The straight sacral length - the distance between the anterior superior margin of the first sacral vertebra and the anterior inferior margin of the last sacral vertebra in the mid plane.
The length of the pubic symphysis - the distance between the upper and lower margin of the symphysis.
The angle of brim inclination - the angle between the plane of the pelvic brim and the projection of a line from the superior border of the pubic symphysis through the tip of the coccyx (Brantigan, 1963).
The bi-parietal diameter of the fetal head where clearly seen, with the head in transverse position, was also measured and in addition the head level in fifths above the pelvic brim assessed.

(3) From the Outlet View (Plate 15)

The sub-pubic angle was measured by Nicholson's technique. (Nicholson, 1938). The angle for measurement was obtained by drawing two straight lines from the mid-point of the inferior border of the pubic symphysis down to meet the pubic rami where they project furthest in (usually near the ischial tuberosities).

CALCULATIONS

From the basic measurements, the following areas and indices were obtained.

To assess the pelvic brim area following Nicholson (1938), the brim was treated as an ellipse and its area calculated from the formula

$$\frac{A.P.I.}{2} \times \frac{Av.T.D.}{2} \times \pi$$

<u>The area of the Outlet</u>, defined anatomically by Nicholson (1938) as a plane bounded by the inferior margin of the pubic symphysis, the ischial spines and the anterior aspect of the last sacral vertebra, was obtained using the antero-posterior outlet and the inter spinous diameter as diameters.

The ratio of the inlet to the outlet area, was established .

From the fetal biparietal diameter, the head area at that level (assuming it to be a circle) and its ratio to the pelvic inlet area, were calculated.

The <u>pelvic brim shape</u> was calculated from the method of Nicholson and Allen (1946) Two indices were used:-

(1) The <u>brim index</u> $\left(\frac{\text{A.P.I.}}{\text{W.T.D.}} \times 100\%\right)$ provided a broad indication of the brim curvature.

(2) A <u>low sagittal index</u> $\left(\frac{\text{P.S.A.P.I.}}{\text{A.P.I.}} \times 100\%\right)$ suggested a flat posterior segment.

From these, Nicholson typed the pelvis, as shown in Table 7.

Finally <u>the mengert index</u> - (A.P.I. x W.T.D.) was calculated.

RESULTS

Pelvic Dimensions

The mean values for each of the diameters and indices measured are recorded in Table 8. In Tables 9, 10 and 11, comparisons are made with those measurements recorded from other series.

A comparison of the measurements recorded in Table 8 shows that there was no statistical difference between the mean measurements of the primary inertia group and the controls at the levels of the pelvic brim and the outlet. The measurements for the group adjudged clinically to have major cephalopelvic disproportion were significantly smaller than those considered to have minor disproportion, and these latter were in turn proved to be smaller than the control group. These differences were shown in each of the measurements at the pelvic inlet and outlet. All differences were significant ($p < 0.05$).

In Table 12, pelvic shape objectively assessed using Nicholson's criteria as displayed in Table 7, is recorded. 79.3% of the total pelvic inlets were gynaecoid in type and 15.3% platypelloid, with very few anthropoid. There was evidence of a trend, in that the percentage of gynaecoid pelves increased and platypelloid decreased from the major disproportion group down through the minor disproportion group, to those with primary uterine dysfunction and the controls. Only one patient in the major disproportion group had an android shaped pelvis, and the majority of those with major disproportion had pelves that were either small gynaecoid or platypelloid.

The straight sacral length (Table 13) was shorter ($p < 0.01$) in the two disproportion groups than in the controls, but there was no statistical difference between the lengths of the pubic symphysis in each of the four groups.

There was no statistical difference in the angle of inclination of

TABLE 8

MEAN PELVIC DIMENSION

	Major Cephalo-pelvic Disproportion (50 cases)	Minor Cephalo-pelvic Disproportion (21 cases)	Primary Dysfunctional Labour (11 cases)	Control (29 cases)
API (cms.)	9.9	10.5	11.4	11.5
Av.TB (cms.)	10.6	11.1	12.0	11.8
Inlet Area (sq.cms.)	83.4	93.8	107.4	102.2
Mengert Index	106.2	119.7	136.7	134.3
APM (cms.)	11.2	11.6	12.1	12.1
APO (cms.)	11.2	11.8	12.1	12.0
ISD (cms.)	8.7	9.4	9.9	9.8
Outlet Area (sq.cms.)	79.9	87.3	94.6	92.4
Subpubic Angle (Degrees)	79.5	79.2	81.7	82.7

TABLE 9

INLET DIMENSIONS

	API in cms.	TDI in cms.	Area in sq. cms.
English (Nicholson 1938)	11.6	13.2	121.0
English (Chosser Moir 1947)	11.8	12.4	115.0
English (Ince & Young 1940)	11.83	13.1	126.8
U.S.A. (Mengert 1954)	11.8	12.4	-
Scottish women $<$5'(Bernard 1952)	10.8	-	106.8
Scottish women $>$5'6" " "	12.7	-	137.6
South African Bantu (Heyns 1946)	10.8	12.0	101.23

TABLE 10

OUTLET DIMENSIONS

	ISD in cms.	APO in cms.	Area in sq. cms.
English (Nicholson 1938)	10.5	13.0	106.7
English (Chossor Moir 1947)	10.45	11.7	-
English (Ince & Young 1940)	9.95	11.97	93.7
South African Bantu (Heyns 1946)	9.7	11.8	88.8

TABLE 11

	Sacral Length (in cms.)	Length of Symph. Pubis (in cms.)
English (Ince & Young 1940)	10.9	-
English (Munro Kerr 1923)	-	5.0
South African Bantu (Heyns 1946)	9.97	3.45

TABLE 12

PELVIC SHAPE
(Objective, using Nicholson's criteria)

	Gynaecoid	Platypelloid	Anthropoid	Android
Major CPD	74.0%	20.0%	4.0%	2.0%
Minor CPD	76.2%	19.0%	4.8%	-
Primary Uterine Dysfunction	81.9%	18.1%	-	-
Control	89.6%	3.5%	6.9%	-
Total	79.3%	15.3%	4.5%	0.9%

TABLE 13

PELVIC FEATURES

	Major CPD (50 cases)	Minor CPD (21 cases)	Primary Uterine Dysfunction (11 cases)	Control (29 cases)
Angle of Brim Inclination - Degrees	63.2	62.1	64.5	62.0
Sacral Length - cms.	9.8	9.8	9.8	9.5
Length of pubic symphisis - cms.	3.6	3.7	3.4	3.5
Inlet Area/ Outlet Area	1.04	1.08	1.14	1.16

the pelvic brim between each of the clinical groups, (Table 13), but all of these African patients had a mean angle which was steeper than that recorded for European patients. In a series of European patients in Salisbury, Rhodesia, the mean angle of inclination of the brim was fifty-six degrees.

The ratio of the inlet area to the outlet area (Table 13), was near to unity in the two disproportion groups.

In Table 14, the biparietal diameter was read from the lateral X-ray pelvimetry only when it could be truly seen and measured. In those cases with a high floating head, or with the head in other than the transverse diameter, the X-ray biparietal diameter could not be assessed.

The biparietal diameter was measurable from 60% of the X-rays in the major cephalopelvic disproportion group, from 71% in the minor group, from 66.6% in the primary inertia and from 55% of the control group. A close correlation was found between the X-ray biparietal diameter measured from the transverse head gripped by the pelvis and the biparietal diameter measured post-partum at birth. Presumably the further reduction by moulding at birth, was compensated for by the skin thickness in the post natal calliper measurement.

There was no significance between either the biparietal diameters or the head areas of the different groups.

The percentage ratio of radiological head area to pelvic brim area was calculated (Table 15). There was no significance between the control and the primary inertia groups, but marked significance ($p < .001$) between each of these and the major cephalopelvic disproportion group. In turn the major group showed a significantly higher ($p < .05$) ratio than was found in the minor group.

There was a close correlation throughout between X-ray head level and the level estimated clinically, using Crichton's method, supported by that of Notelowitz, of describing the amount of head palpable in fifths above the pelvic brim. From Table 16 the mean clinical levels at time of X-ray are shown, along with the actual levels seen on X-ray. In 90% of cases, the clinical findings agreed with the radiological and in no instance was the difference between the two greater than one-fifth. The fact that none were obese and that the majority of patients had epidurals facilitated clinical assessment and contributed to the clinical accuracy.

Table 17 showed a significant difference ($p < 0.05$) in height between those with major disproportion and the controls. There was no statistical difference in birth weights between the different groups. Fetal size was less, but only slightly so, than in the data derived from European populations (Ellis, 1951).

TABLE 14

BIPARIETAL DIAMETERS

	Major CPD (30 cases)	Minor CPD (14 cases)	Dysfunctional Labour (8 cases)	Control (16 cases)
Mean Caliper BPD – in (following birth) cms.	9.1	9.1	9.2	9.1
Mean Intrapartum Xray – in BPD cms.	9.2	9.2	9.3	9.2

TABLE 15

RELATIVE CEPHALO-PELVIC DIMENSIONS

	Major CPD (30 cases)	Minor CPD (14 cases)	Primary Uterine Dysfunction (8 cases)	Control (16 cases)
Xray head area (πr^2) (Mean in sq. cms)	66.3	67.3	68.2	67.2
Inlet pelvic area (Mean in sq. cms.)	83.4	93.8	107.4	102.2
Mean Xray head/ Pelvic area x 100%	80.2	73.7	65.6	64.0

TABLE 16

HEAD LEVELS IN FIFTHS ABOVE THE PELVIC BRIM

	Major CPD	Minor CPD	Primary Uterine Dysfunction	Control
Mean Xray head level	3.7	3.5	2.5	2.5
Mean Clinical head level	3.9	3.7	2.8	2.9

TABLE 17

Mean Patient Height and Birth Weight

	Major CPD (50 cases)	Minor CPD (21 cases)	Primary Uterine Dysfunction (11 cases)	Control (29 cases)
Mean Patient Height (in cms.)	151.3	155.6	155.0	156.8
Mean Infant Birth Weight (in gms.)	3118.6	3044.1	2936.8	2882.4

DISCUSSION

The Prognostic Accuracy of an Active Trial of Labour

In this study, the radiological results bear out the prognostic accuracy of the actively managed Trial of Labour. Reliably, without risk to mother or child, Philpott's (Philpott and Castle, 1972) active management of dysfunctional labour, predicted and separated the degree of cephalopelvic disproportion into one of three groups - Primary uterine dysfunction with no underlying disproportion, dysfunctional labour secondary to minor disproportion, or dysfunctional labour secondary to major disproportion. X-ray pelvimetry in the management of the primigavida, where no other problem contra-indicates Trial of Labour, is therefore unnecessary.

The Radiological Pelvic Features

The various data were compared with the dimensions found in other populations. Tables 8 & 9 show that each of the Harari groups was smaller in inlet dimensions than those patients studied in England, Scotland or U.S.A., and most closely approximated to the South African Bantu in Heyns's study (1946). The fact that of the Harari groups, the "control", selected and representing the most ample pelvis, was only one square centimetre greater in mean pelvic brim area than Heyns's overall mean, would suggest that the average pelvic dimensions amongst the Shona patients delivered at Harari Hospital were considerably less than those of the South African Bantu in the Transvaal, studied by Heyns. Tables 8 & 19 also demonstrate that despite a higher mean stature the minor cephalopelvic disproportion group, here reported, had smaller pelvic dimensions than the one hundred Scottish women under five feet in height, studied by Bernard (1952).

By various other generally accepted criteria the Harari pelvis was small. Mengert (1954) using his index, (Table 8) found that where capacities were reduced below 90% of the average (M.I = 131.5), the difficulties and dangers of vaginal delivery progressively increased. Nicholson (1938) found that ninety square centimetres was the critical area of the brim inlet. A pelvis of ninety square centimetres would pass 70% of heads and a pelvis of eighty square centimetres, not more than 21%. From Table 8 it can be seen that the mean brim areas in the major and minor cephalopelvic disproportion groups, straddled this critical area of ninety square centimetres! Greenhill (1965) defined pelvic contraction as the shortening of one or more of the cardinal diameters by one centimetre or of one diameter by two centimetres, and accepted as the normal, an antero posterior inlet of 12.0 cms. and a transverse diameter of 13.5 cms. By Greenhill's criteria, the Harari control group pelvis was small!

Tables 8 & 10 show that the interspinous diameter, the antero posterior of the outlet, and the outlet area were also smaller in comparison against the other populations.

Looking at the shape of the pelvic brim, the Harari pelvis can be seen to be essentially round. Even in the major cephalopelvic disproportion group this was the case - 74% were gynaecoid, 20% platypelloid, 4.0% anthropoid and only 2.0% android. While the results cannot strictly be compared against those of Kenny (1944) who grouped the pelves morphologically into the Caldwell Maloy classification, her results are of interest. She looked at the X-ray pelvimetries of one thousand English women with disproportion and found that only 34.8% were gynaecoid in type. 20.3% were android and a further 36% were combinations of android and gynaecoid. 6.4% were anthropoid and 1.8% platypelloid. 82.5% of the android group required operative delivery and 34.9% Caesarean

Section, as compared with only 12.9% of the gynaecoid group with a Caesarean Section rate of 3.7%. The android pelvis, therefore, featured prominently in the cephalopelvic disproportion studied in his series, in marked contrast to the Harari pelvis where only about 1% had an android pelvis and the dominant type was gynaecoid.

The lengths of the pubic symphysis and the sacrum together indicate the length of the bony birth canal. Compared with the dimensions in Table 11 the findings showed a shallow true pelvis or short birth canal. The angle of brim inclination was higher in the African groups than that of the European series surveyed. This may be attributable to the short pubic symphysis, as postulated by Zvanovik (1968), and as found in this series from Harari Hospital. The increased angle of brim inclination would appear to explain the late head descent in the first stage of labour, common in the African patient.

There was no significant difference between the subpubic angles (Table 8) of the Harari groups, but these were less than those of Europeans, the control group sub-pubic angle being smaller than Chassar Moir's (1947) subpubic angle of 86% or Nicholson's (1938) of 84.8^{o} .

THE CLINICAL SIGNIFICANCE OF THE RADIOLOGICAL FINDINGS

The Harari pelvis tended to be gynaecoid in type, shallow and with no funnelling, a characteristic retained even where the pelvis was most contracted. As pointed out by Heyns (1944), since the circle, of all perimeters, encloses the greatest area, the round pelvis is most favourable to labour. The fact that cephalopelvic disproportion is not an even greater problem than it is, can be attributable perhaps to these anatomical features.

The pelvic outlet area reflected accurately the size of the inlet indicating nearly parallel side walls. In the major and minor cephalopelvic disproportion groups, the ratio of outlet to the inlet was almost unity. Similarly the interspinous diameter reflected the transverse diameter of the brim. In the African pelvis, therefore, as compared to the European, while assessment of brim cephalopelvic disproportion is rendered more difficult by the customary high position of the head, the lower reaches of the pelvis which are easiest to measure clinically reflect the inlet dimensions. If the head passes the brim it will almost certainly pass through the outlet.

X-ray measurement of the biparietal diameter proved more reliable in this series than was predicted by Crichton (1952), although only those cases where the dimensions could be identified without doubt were taken. The Harari X-rays however were taken during labour when the head was flexed and moulded. With the vertex in the transverse position, held firmly in the brim, with little room for movement from the midline in the contracted round African pelvis, the conditions for cephalometry were optimal. The findings agreed with Chassar Moir's contention that, where the biparietal diameter can be clearly seen, it can be accur tely measured.

The ratio head/pelvic area confirmed retrospectively both the reliability of clinical impression and of X-ray cephalo pelvimetry read with the vertex in the occipito transverse position. The ratios of head to pelvic area as determined by X-ray would suggest that for easy delivery the head relationship should not exceed 68%. This compares with Nicholson's finding (1938) although his figure is somewhat higher, attributable to the fact that he was using diameters calculated following delivery rather than the intra-natal moulded fetal diameters.

THE ROLE OF RADIOLOGICAL PELVIMETRY IN AFRICAN OBSTETRICS

Remembering that the value of any diagnostic technique lies in its ability to produce information not otherwise obtainable, how necessary radiological pelvimetry is, in a developing country where facilities are scarce, must be further determined.

How otherwise can the pelvis be accurately assessed? Although Bernard, (1952) pointed out that the degree of mechanical difficulty encountered seemed to be inversely proportional to the patient's height, this is not necessarily the case for the individual patient. Nor is it possible to identify from the patient's physique, her pelvic dimensions. Kenny (1944) emphasised that stature alone was no indication of pelvic size nor did the width of the hip region bear any relationship to the transverse pelvic dimensions. In the present investigation, while the mean height in the gross cephalopelvic disproportion group (Table 17) was significantly different from those of the other groups, in fact, at individual level there was a wide range. Out of the fifty cases in the major cephalopelvic disproportion group, five patients were taller than five feet three inches; six were below four feet ten inches.

Similarly, clinical estimation of the brim area and the obstetric conjugate can be notoriously unreliable and misleading. Kenny in her series found that in 96% of cases, the clinical conjugate vera was wrong compared with the X-ray, and Williams (1942) stated "Even the most skilled observer is capable of being deceived. The estimation of possible cephalopelvic disproportion between head and pelvis, is one of the most difficult things in obstetrics".

While it has been generally acknowledged that the radiological pelvic brim area reflects in a range, the probable outcome of labour, its value is limited by other variables such as the strength of the uterine forces, the position of the fetal head and the degree of safe fetal and pelvic moulding. These imponderables make it impossible to predict absolutely the outcome and to prognosticate with accuracy for the individual.

It has been demonstrated in this study that X-ray pelvimetry in the primigravid with no obstetric problems other than possible cephalo-pelvic disproportion is not necessary. The degree of disproportion was accurately predicted clinically during Trial of Labour, without jeopardising the fetus. An X-ray taken is of real value only if the attendant is prepared to waive oxytocic stimulation of dysfunctional labour, and this should rarely be required. The results of the Trial must depend upon the progress of the labour and the fetal and maternal condition.

There are, however, circumstances where fetus and mother or both may be exposed to considerable risk by Trial of Labour and radiological pelvimetry is of great value. Perlmann (1973) recently demonstrated how contracted pelvis contributes to the high fetal mortality rate in African breech delivery. The other major risk is that of uterine rupture in the multiparous patient, in the presence of any degree of cephalopelvic disproportion or where the uterus has been scarred and weakened by previous surgery.

In such instances risk must be avoided. The pelvis must be assessed as accurately as possible to indicate those cases where there might be mechanical difficulty. The experienced observer can clinically assess the inlet from the outlet. If facilities are available, however, then exact radiological measurements are most desirable. The dimensions compared against those suggested by this investigation will improve clinical judgement and better predict whether or not pelvic contraction is present. If not available, clinical pelvic assessment plus other criteria, to be later discussed, for detecting cephalopelvic disproportion became of paramount importance.

FETAL RESPONSE TO CEPHALOPELVIC DISPROPORTION

Fetal distress is usually associated in Obstetrics with hypoxia. Another form of stress, however, mechanical in type, to which the fetus can be subjected occurs when the presenting head may be excessively compressed during labour by passage through a contracted pelvis. The already well documented features of hypoxic fetal distress need not necessarily apply to a fetus suffering from the pressure effects of cephalopelvic disproportion.

In this section, the fetal condition and nature of response during augmented Trial of Labour, to the possible excessive head compression encountered in cephalopelvic disproportion are examined by looking specifically at the fetal heart response, as shown on the Hewlett Packard cardiotocograph trace, and the pH changes.

The other features, excessive head moulding and the presence of meconium, suggestive of fetal distress in response to disproportion, are considered later, along with the clinical features of cephalopelvic disproportion.

RESULTS.

As stated on page 45, to provide a true hypoxic group against which to compare the traces from the dysfunctional labour groups, twenty patients in the "high hypoxic risk category" were selected. Cephalopelvic disproportion was not present in these patients, and fetal hypoxia in labour as evidenced by a low pH or a low Apgar score at birth, was the sole abnormality.

For the purpose of analysis, the fetal heart rate records were divided into hourly segments preceeding delivery, and each case placed into one of the four categories -

Major cephalopelvic disproportion;
Minor cephalopelvic disproportion;
Control and
Hypoxic.

The fetal heart rate patterns were interpreted in the main according to the classification given by Beard (1971). The five components of the continuous record of the fetal heart rate looked at in this investi-:gation require definition (Fig 2).

1. The base line fetal heart rate was the rate recorded between contractions. The following variations were seen:-

<u>Normal</u> - 120 - 160 beats per minute.

<u>Tachycardia</u> - greater than 160 beats per minute.

<u>Bradycardia</u> - less than 120 beats per minute.

2. <u>Beat-to-Beat Variation:</u>

The HP monitor is triggered by the R wave peak of the fetal E.C.G. Normally (Beard 1971) the interval between each complex pair is variable - the normal range being about eight beats to a minute. Normal fetal heart rate beat-to-beat variation is maintained by a continuous fluctuating balance between the vagal and sympathetic tones of the fetal nervous system. Flattening, or smoothing suggests a C.N.S. blocking effect, with the heart beating in isolation, and is an associated feature of fetal hypoxia. In this investigation, the variations were interpreted as follows:-

< 5 = Flattening

5-20 = Normal

> 20 = Exaggerated

3. <u>Fetal Heart Rate Patterns</u> were the changes in fetal heart rate occurring during uterine contractions. These might be accelerations or decelerations (dips). Of particular significance in relation to the decelerations was the time of onset, the time of completion and the presence of a time lag. Time lag, first described by Caldeyro-Barcia et al (Beard 1966) was defined as the time gap between the peak of uterine contraction and the lowest point of the fetal heart rate deceleration after the contraction (Plate 23).

<u>Acceleration Patterns</u> showed an increase in fetal heart rate above the base line rate during the contraction phase.

<u>Early Decelerations</u> were characterised by the onset of the deceleration early in the contraction phase with recovery to the base line rate by the end of the contraction. There was no time lag (See Fig. 2)

<u>In Late Decelerations</u> (Fig. 2 and Plate 23) there was a time lag, the deceleration began late in the contraction phase, with a recovery following completion of the contraction.

<u>A further Group of Decelerations</u>, however, became apparent as the investi-:gation proceeded. The deceleration began with the contraction, there was no time lag, but recovery to the base line was delayed beyond the end of contraction. These decelerations were described as being <u>"early prolonged"</u> (Fig. 2 Plate 24).

4. <u>Dip Area</u> Following Shelley and Tipton (1971) the dip area was calculated. This was described as being the total number of fetal heart beats which would have occurred had there been no decelerations, and quantified the decelerations per hour in an objective manner, which took no account of the time relationship to the contraction pattern.

The amplitude, frequency and duration of the decelerations per hour were reflected in the total dip area.

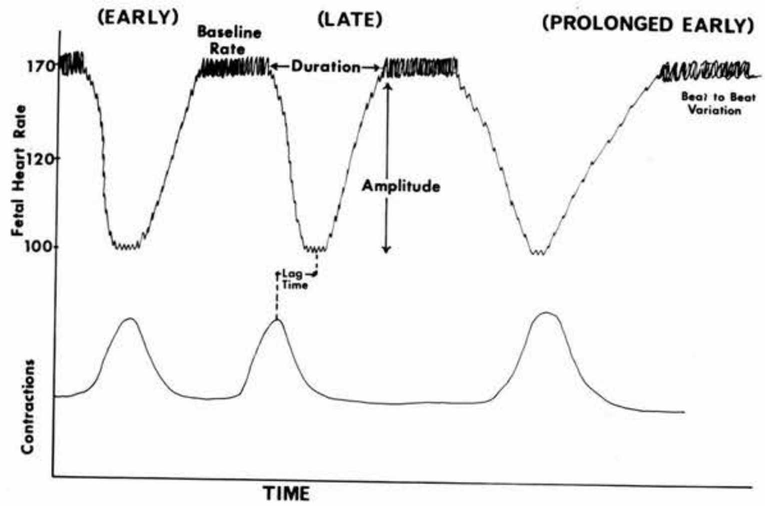
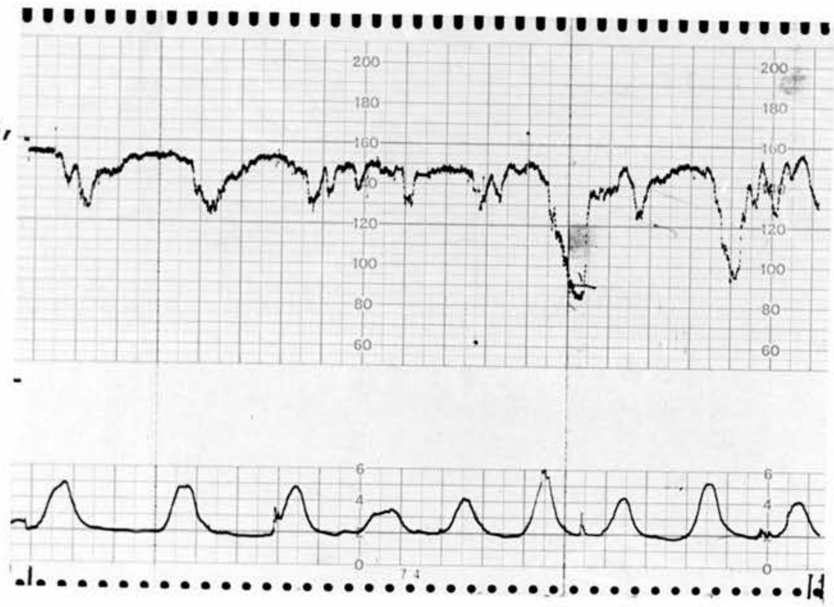


FIGURE 2.

Features of the Fetal Heart record.

PLATE 23.

Late decelerations, showing the time lag.



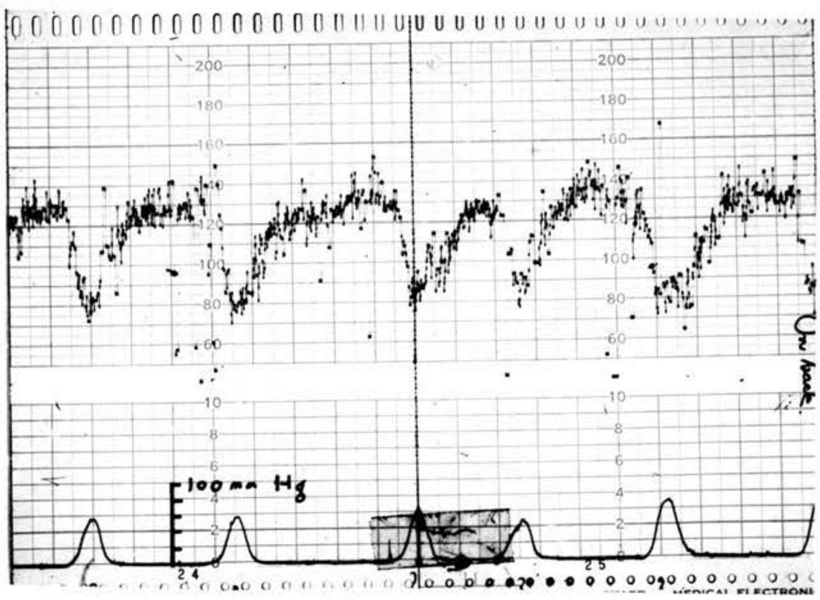


PLATE 24.

Early prolonged decelerations

5. <u>The Total Time Lag</u> was calculated by adding together the individual late deceleration time lags in each hour.

These various features were analysed and compared between the various groups (see Figures 3 to 13 and Tables 18 to 23).

Because of technical failures and incomplete traces, in fact, 8% of the fetal heart traces could not be fully analysed and were therefore excluded. This left forty-six traces from the major disproportion group, nineteen from the minor and twenty-seven from the control group to be examined, along with the twenty "hypoxic" traces. The number of patients in each clinical group in the fourth, third, second and first hour before delivery are shown in Table 18.

Median figures and trends are presented.

<u>The Fetal Heart Rate</u> (Table 18) remained within normal limits in all of the control cases, and in most of the minor group, the sole exception being in the third hour before delivery, where 8% showed tachycardia.

In the major group, again the fetal heart rate predominantly remained within normal limits, though to a steadily lessening degree with duration of trial of labour. Tachycardia became gradually more pronounced, with bradycardia present only in the fourth hour before delivery where 6% of cases showed it. In the hypoxic group, in the hour prior to delivery 70% had a normal fetal heart rate base line, with 25% showing tachycardia and 5% bradycardia.

<u>Table 19</u> shows some flattening of beat-to-beat variation in the control group with a 12% incidence of this in the second and first hours before delivery. This compared against a five times higher incidence of flattening in the hypoxic group. In the major cephalopelvic

TABLE 18

BASELINE FETAL HEART RATE

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	90% N $\boxed{34}$ 4% T 6% B	80% N $\boxed{40}$ 20% T	85% N $\boxed{46}$ 15% T	78% N $\boxed{46}$ 22% T
Minor CPD Group	100% N $\boxed{15}$	92% N $\boxed{16}$ 8% T	100% N $\boxed{19}$	100% N $\boxed{19}$
Control Group	$\boxed{19}$ 100% N	$\boxed{20}$ 100% N	$\boxed{26}$ 100% N	$\boxed{27}$ 100% N
Hypoxic Group			81% N $\boxed{20}$ 19% T	70% N $\boxed{20}$ 25% T 5% B

N = Normal (120-160 beats/min.)
B = Bradycardia (<120 beats/min.)
T = Tachycardia (>160 beats/min.)
($\boxed{X}$ X = Number of patients)

TABLE 19

BEAT TO BEAT VARIATION

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	64% N 20% F 16% E	67% N 24% F 9% E	72% N 20% F 8% E	72% N 24% F 4% E
Minor CPD Group	100% N	77% N 12% F 11% E	76% N 16% F 8% E	70% N 12% F 18% E
Control Group	100% N	92% N 8% F	88% N 12% F	88% N 12% F
Hypoxic Group			45% N 55% F	35% N 65% F

N - Normal = Beat to beat variation of 10 - 30
F - Flattening = Beat to beat variation of < 10
E - Exageration = Beat to beat variation of > 30

disproportion group, flattening of beat-to-beat variation was present in 20%+of cases in each of the last four hours of delivery. This was approximately twice the incidence occurring in the minor cephalopelvic disproportion group.

From Figure 3, the dip area was demonstrably more marked in the hypoxic group, and thereafter to a decreasing degree in the major, minor and control groups, with an increase in each as labour progressed. This compared against the dip areas of Shelley and Tipton (1971) as shown in Table 20.

The levels and trend of total time lag (Figure 4), follow those of the dip area.

Figure 5 demonstrates the acceleration pattern per number of contractions occurring in each hour.

The total number of decelerations for each group in each hour was calculated, and in order to compare meaningfully against the other types of dip and the other groups, was expressed as a percentage of the total number of contractions occurring in that hour. The results are displayed in Figures 7 to 13.

In the Control Group (Figure 6), there were no early prolonged decelerations, only a negligible number of late decelerations, but an increasing proportion of early decelerations were shown as labour progressed, to reach a maximum of about 15% in the final hour before delivery. This incidence is lower than that reported by Althabe et al (1969), who found a 50% incidence of Type I dips with the membranes ruptured, the cervix at least 6 cms. and the head engaged. In early labour the incidence was 2% - 5%.

In the hypoxic group (Figure 7), the late deceleration predominated, with 56%+ occurring in the penultimate and final hours before delivery.

FIG. 3

MEAN DIP AREA/HOUR/PATIENT

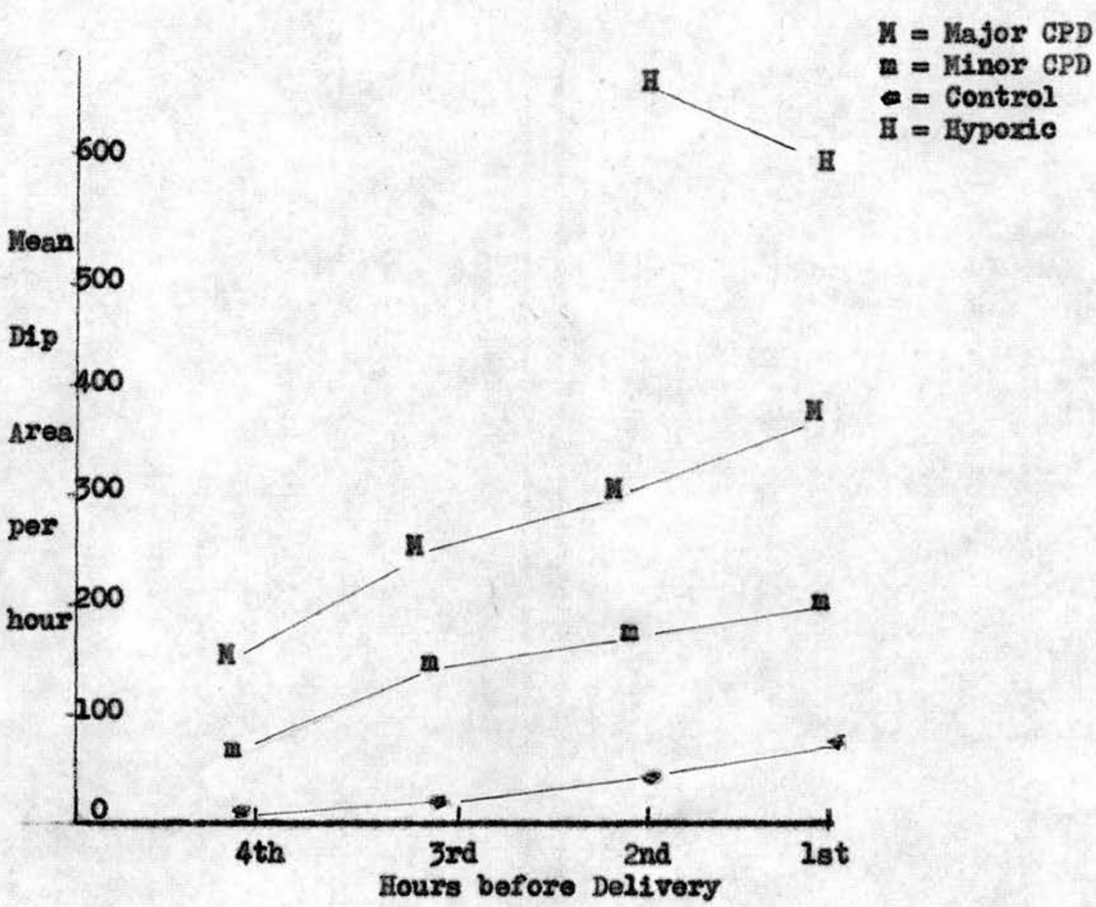


TABLE 20

(FROM SHELLEY & TIPTON, 1971)

Dip Area / Hour	No. of Patients	Mean Apgar Score at 1min.	Mean pH of U.V. blood
< 200	37	8.6	7.30
200-499	41	7.6	7.28
500-799	12	6.7	7.24
800+	10	3.4	7.15

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 3

MEAN DIP AREA/HOUR/PATIENT

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	149	233	271	337
Minor CPD Group	53	126	137	142
Control Group	0	20	43	63
Hypoxic Group	-	-	650	604

FIG. 4

MEAN TOTAL TIME LAG IN SECS/HOUR/PATIENT

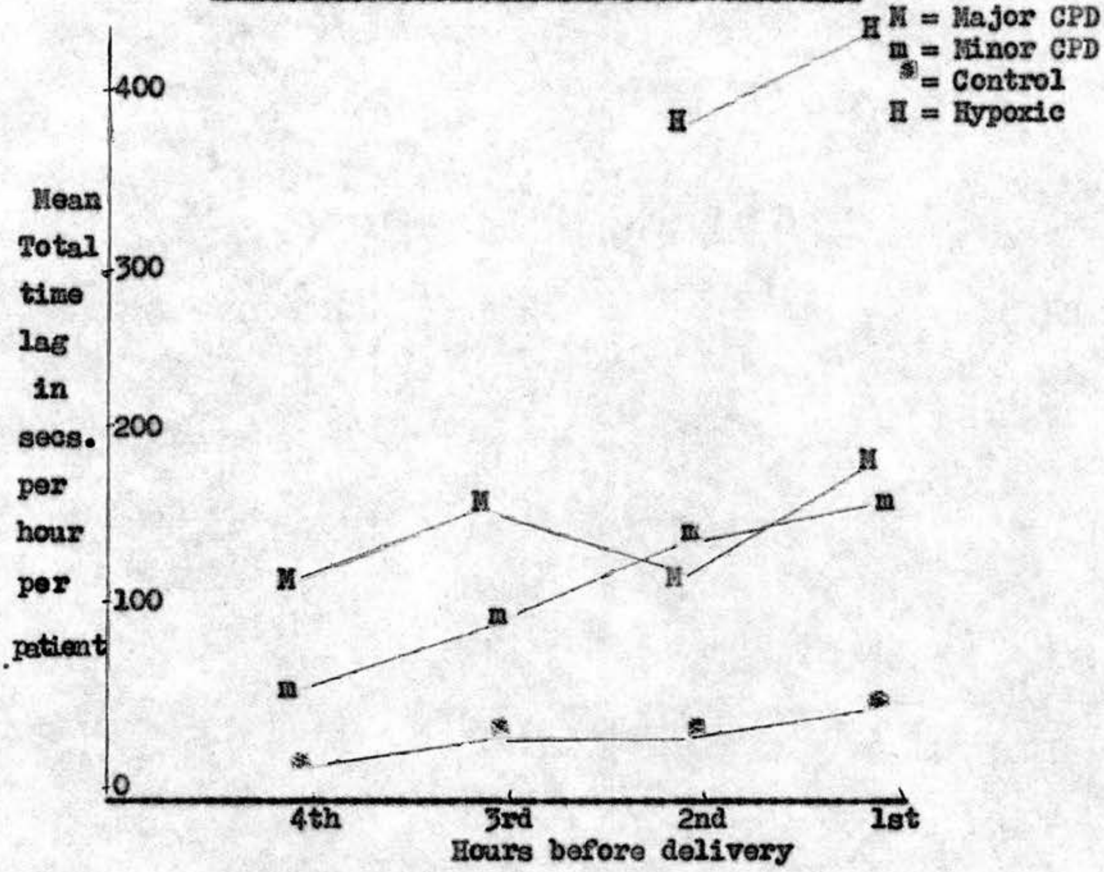
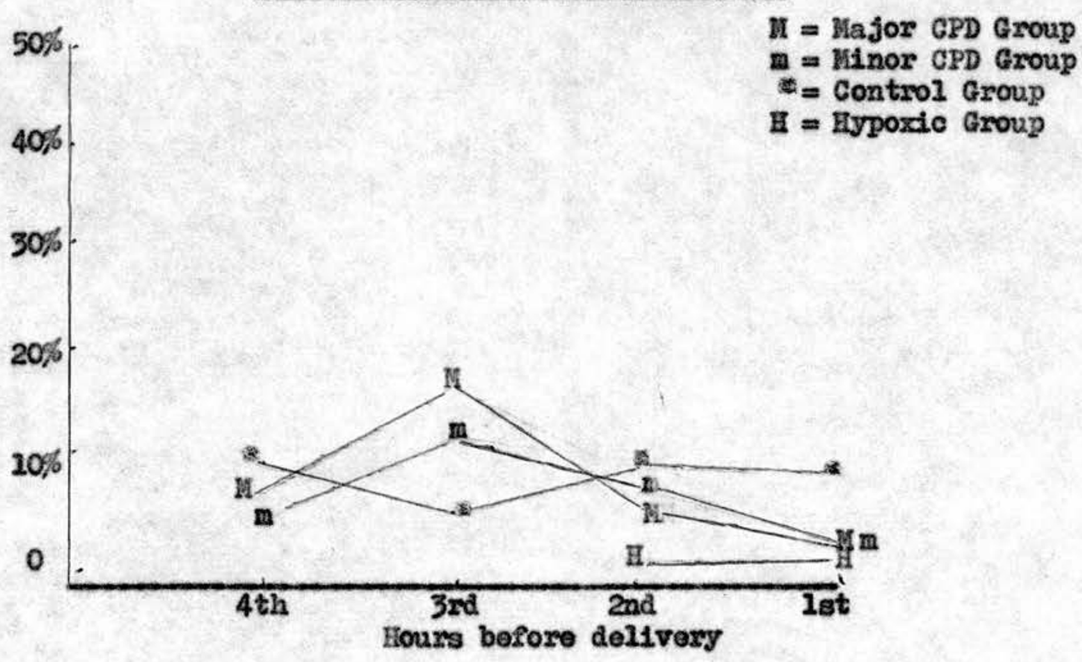


FIG. 5

% ACCELERATIONS/CONTRACTIONS/HOUR



SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 4

MEAN TOTAL TIME LAG IN SECS/HOUR/PATIENT

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	108	133	106	153
Minor CPD Group	38	86	126	130
Control Group	0	11	10	25
Hypoxic Group	-	-	386	401

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 5

% ACCELERATIONS/CONTRACTIONS/HOUR

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	2. 5	12.0	4.25	1.0
Minor CPD Group	2. 5	9.5	5. 0	1.0
Control Group	7.25	4.0	6.0	5.1
Hypoxic Group	-	-	0	0

FIG. 6

CONTROL GROUP

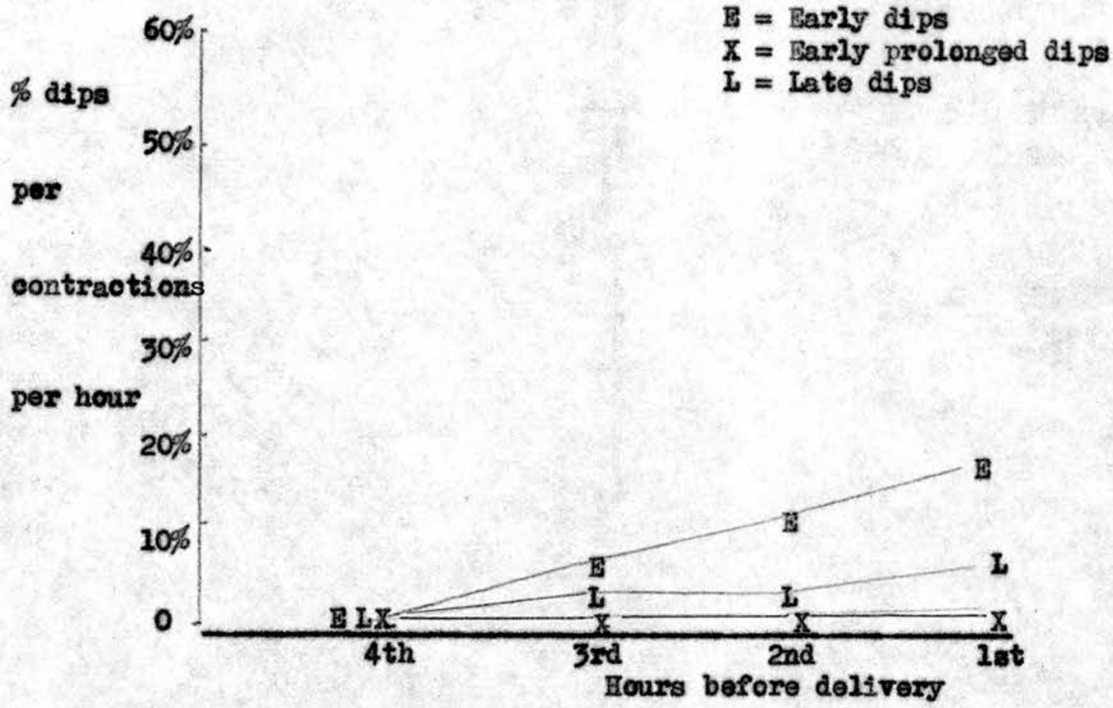
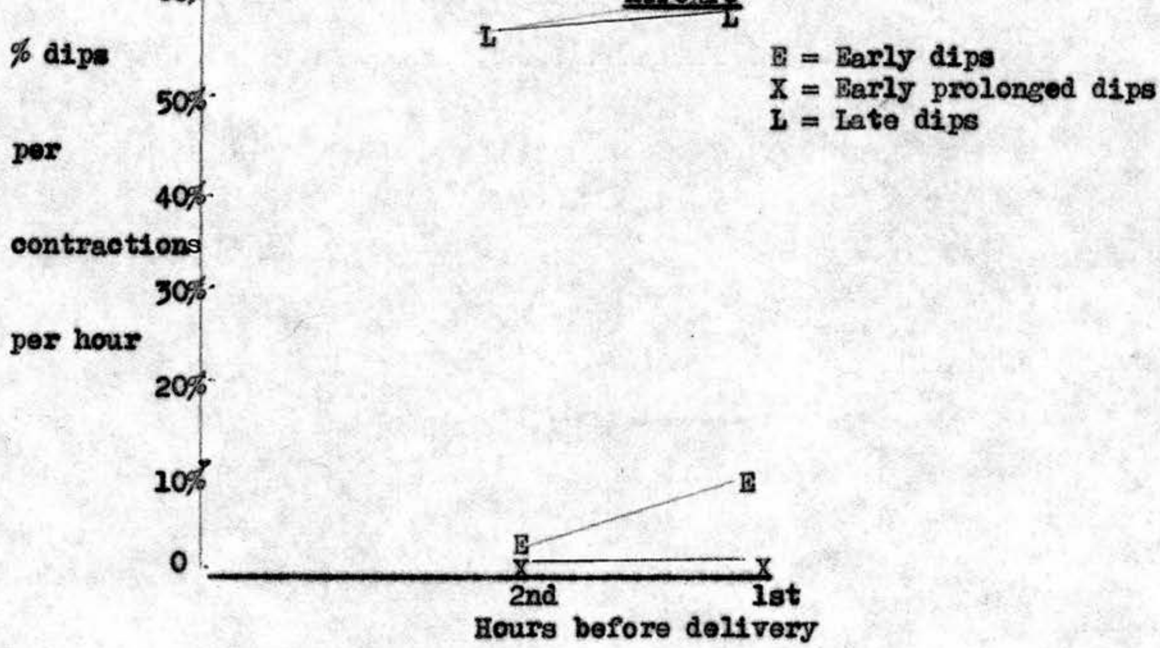


FIG. 7

HYPOXIC



SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 6

CONTROL GROUP

	Hours before delivery			
	4th	3rd	2nd	1st
% Early dips/ contractions/hour	0	5.3	8.4	15.1
% Early prolonged dips/ contractions/hour	0	0	0	0
% Late dips/contractions /hour	0	2.3	1.3	3.2

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 7

HYPOXIC GROUP

	Hours before delivery	
	2nd	1st
% Early dips/ contractions/hour	1.7	7.1
% Early prolonged dips/ contractions/hour	0	0
% Late dips/contractions/ hour	56.6	59.3

In the Major Group the pattern as presented in Figure 8 was one of an increasing number of early prolonged decelerations, accompanied by late decelerations in ever increasing proportion as the Trial of Labour proceeded. In the minor cephalopelvic disproportion group, Fig. 9, the pattern was followed to a lesser degree.

From Figure 10, the greatest frequency of total number of fetal heart rate decelerations occurred in the hypoxic group, followed in turn by the major cephalopelvic disproportion, the minor cephalopelvic disproportion and then the control groups. Within each group there was an increased frequency of deceleration, with increased duration of labour, except in the major cephalopelvic disproportion group where the total number of fetal heart rate dips in each of the last three hours was fairly constant.

In the Hypoxic Group (Figure 7) the rise in the late decelerations (Figure 12) accounted for this increased frequency, and in the control group (Figure 6), the increased frequency could be attributed to early decelerations (Figure 11).

The early decelerations, at first most marked in the major cephalopelvic disproportion group (Figures 8 and 11), reached a maximum at three hours before delivery. A balance between the falling number of early dips on the one hand and the increasing number of late dips on the other, kept the total number of decelerations constant. The late dips which predominated at the end showed only a slight increase through labour to time of delivery (Figures 8 and 12).

In the Minor Group, the rising trend of dip was due more to an increased number of early dips than to early prolonged dips, with each contributing equally in the last hour (Figures 9, 11 and 13). Of interest was the fact that in this group, the highest percentage of early

FIG. 8

MAJOR C.P.D. GROUP

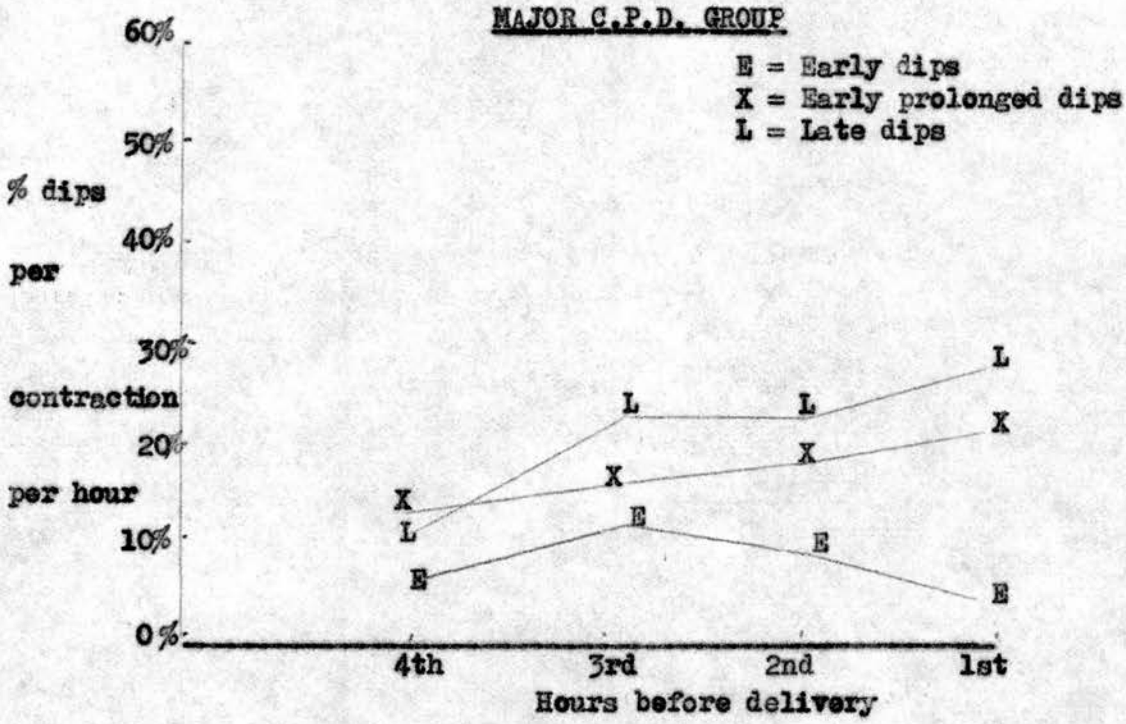
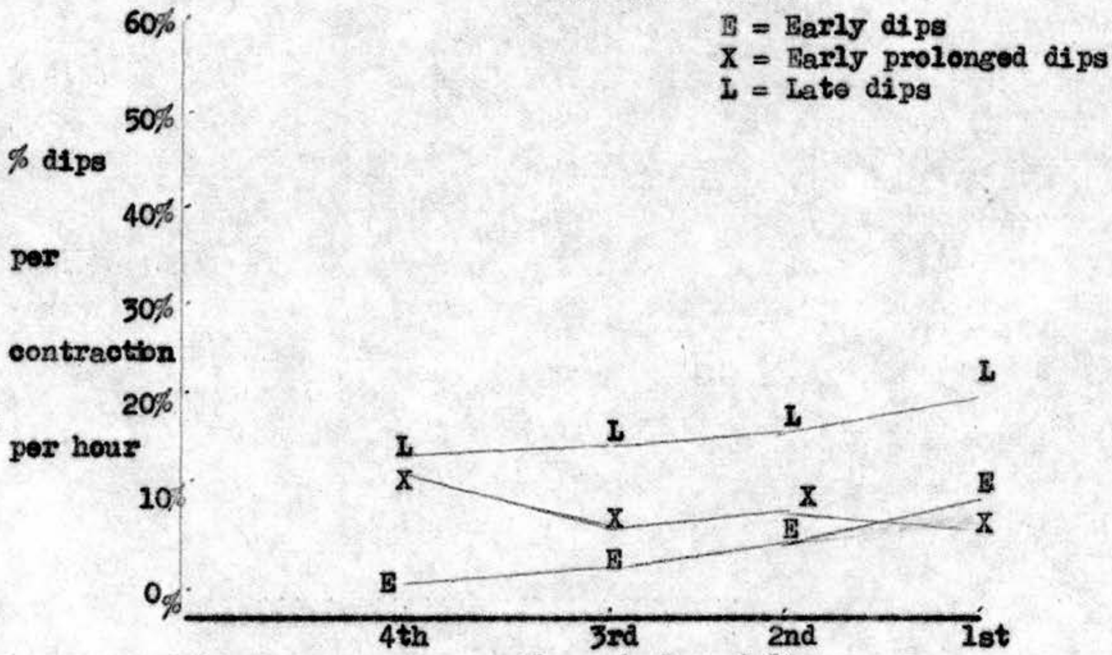


FIG. 9

MINOR C.P.D. GROUP



SUPPLEMENTARY TABLE TO ACCOMPANY FIG: 8

MAJOR CPD GROUP

	Hours before delivery			
	4th	3rd	2nd	1st
% Early dips/ contractions/hour	6.4	10.5	7.6	4.9
% Early prolonged dips/ contractions/hour	11.2	13.9	15.2	16.7
% Late dips/contractions/ hour	10.0	21.3	21.2	24.2

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 9

MINOR CPD GROUP

	Hours before delivery			
	4th	3rd	2nd	1st
% Early dips/ contractions/hour	1.0	2.6	4.9	9.9
% Early prolonged dips/ contractions/hour	12.4	7.7	9.1	8.2
% Late dips/contractions/ hour	14.3	14.9	16.1	20.3

FIG. 10

% TOTAL NUMBER OF DECELERATIONS/CONTRACTIONS/HOUR

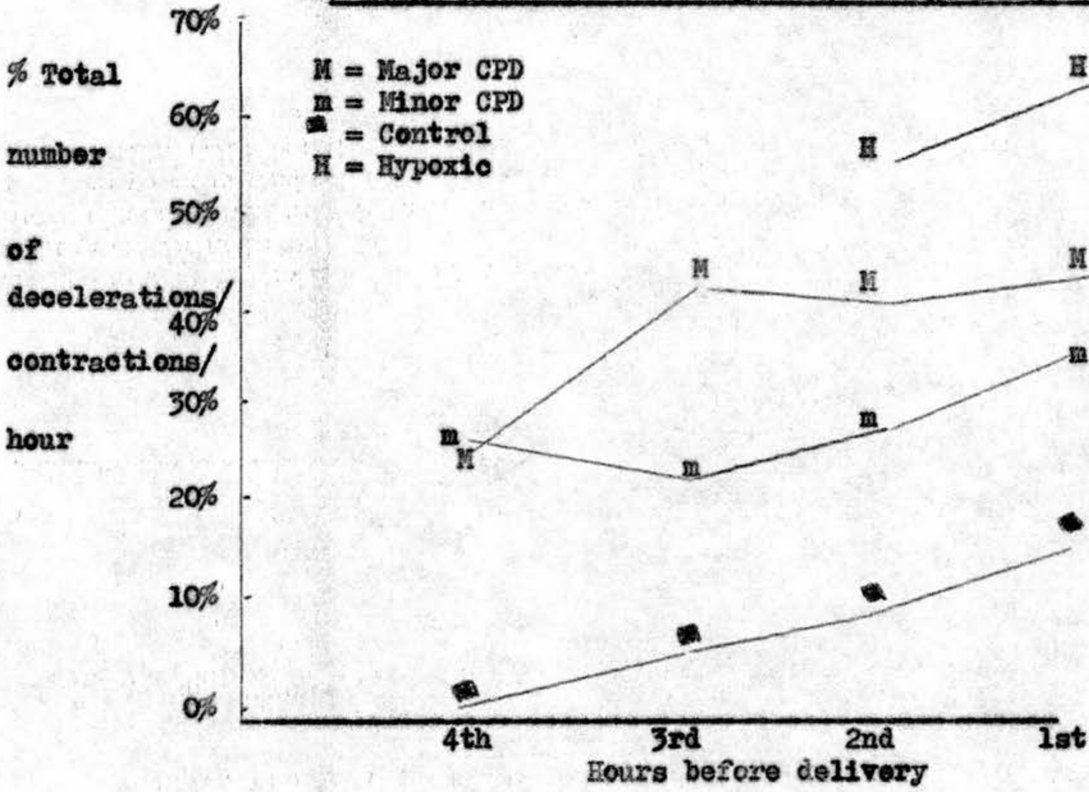
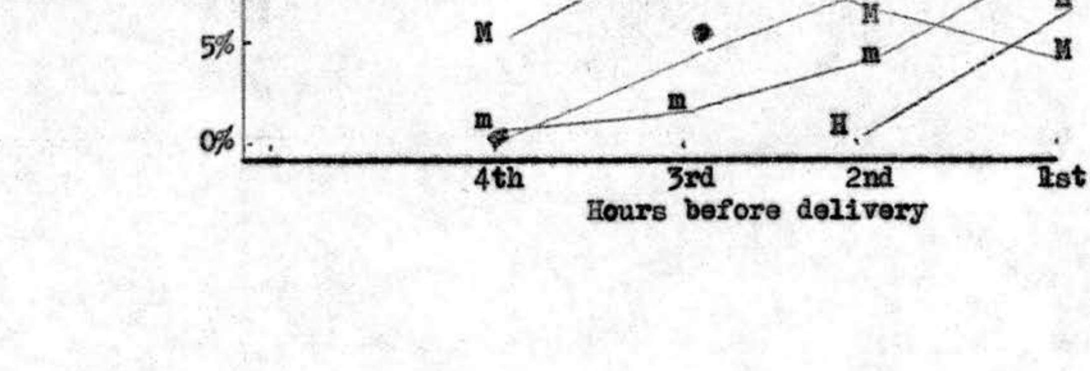


FIG.11

% EARLY DIPS/CONTRACTIONS/HOUR



SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 10

% TOTAL NUMBER OF DECELERATIONS/CONTRACTIONS/HOUR

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	27.6	45.7	44.	45.8
Minor CPD Group	27.7	25.2	30.1	38.4
Control Group	0	7.6	9.7	18.3
Hypoxic Group	-	-	58.3	66.4

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 11

% EARLY DIPS/CONTRACTIONS/HOUR

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	6.4	10.5	7.6	4.9
Minor CPD Group	1.0	2.6	4.9	9.9
Control Group	0	5.3	8.4	15.1
Hypoxic Group	-	-	1.7	7.1

FIG. 12

% LATE DIPS/CONTRACTIONS/HOUR

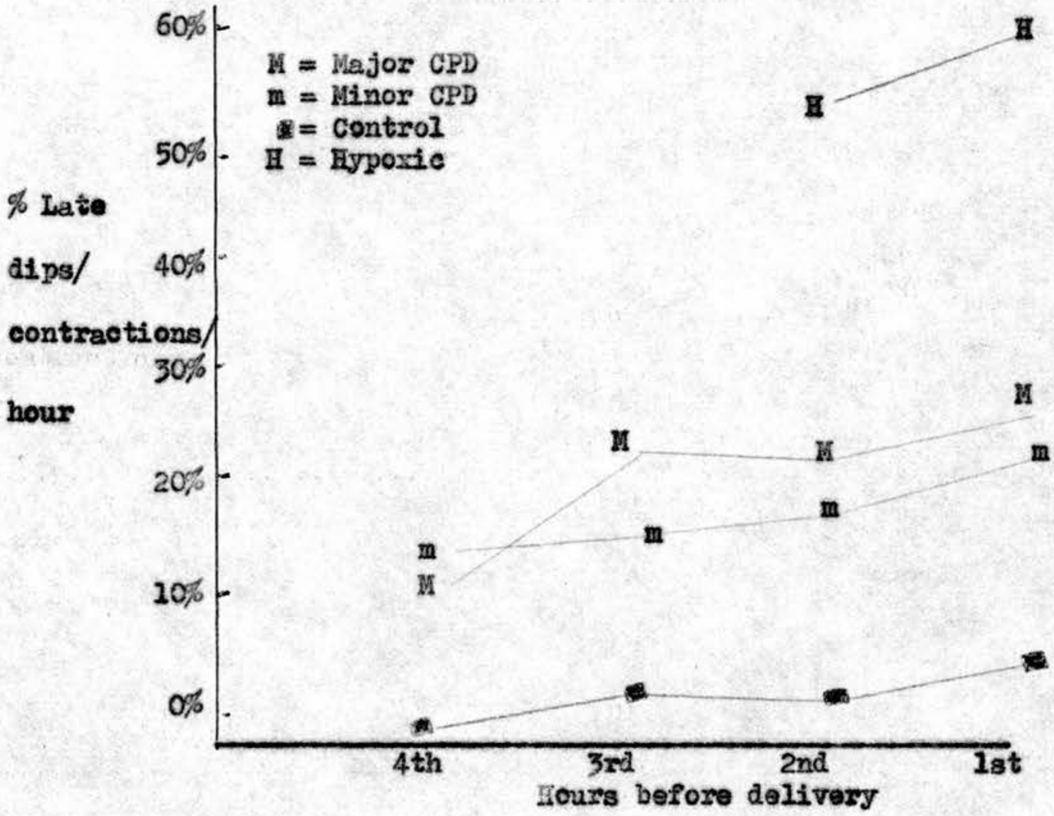
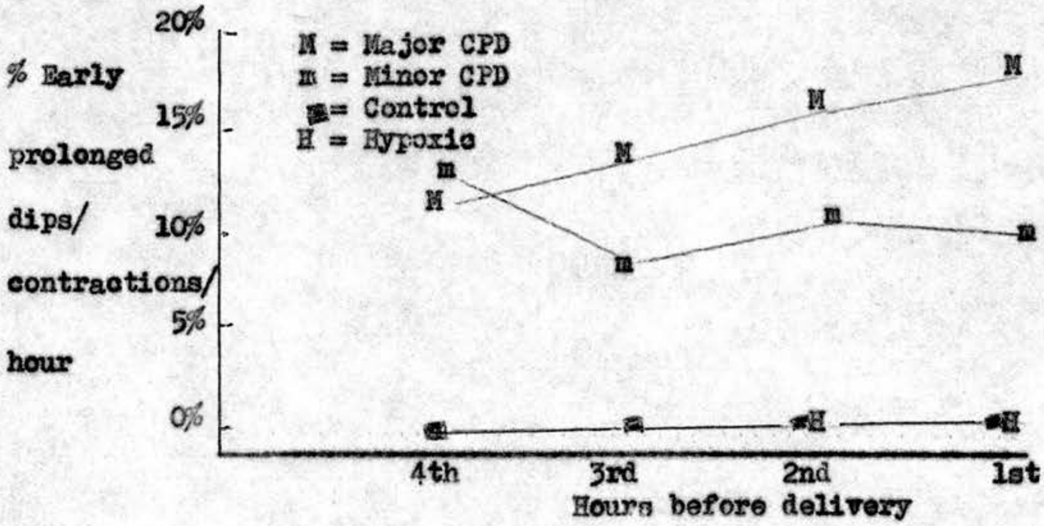


FIG. 13

% EARLY PROLONGED DIPS/CONTRACTIONS/HOUR



SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 12

% LATE DIPS/CONTRACTIONS/HOUR

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	10.	21.3	21.2	24.2
Minor CPD Group	14.3	14.9	16.1	20.3
Control Group	0	2.3	1.3	3.2
Hypoxic Group	-	-	56.6	59.3

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 13

% EARLY PROLONGED DIPS/CONTRACTIONS/HOUR

	Hours before delivery			
	4th	3rd	2nd	1st
Major CPD Group	11.2	13.9	15.2	16.7
Minor CPD Group	12.4	7.7	9.1	8.2
Control Group	0	0	0	0
Hypoxic Group	-	-	0	0

prolonged dips occurred in the fourth hour, the time at which the head was passing down through the pelvic brim!

The fetal heart rate dips were looked at specifically in respect of time of onset, time of completion, duration and amplitude.

In the Early Dips(Table 21), duration tended to increase towards delivery in the major cephalopelvic disproportion group, although this was not the case in the control group. Duration of the contractions over all was maximum in the hypoxic fetus. Amplitude throughout varied between 20 and 40 beats. This compared with Beard's series (1971) where the amplitude did not exceed 40 beats per minute.

In the Early Prolonged Deceleration (Table 22), the duration of the dip was less throughout in the minor as compared to the major cephalopelvic disproportion group. Similarly, in amplitude the minor cephalopelvic disproportion group decelerations were in the main less than the major and averaged about 30 beats. Time of onset was similar in the various groups and hours so that in the major compared to the minor cephalopelvic disproportion group the increased duration reflected the demonstrated increased time of recovery to the fetal heart rate base line.

In the Late Decelerations (Table 23), the duration of the dip was greatest in the hypoxic group, followed in turn by the major, the minor and the control groups.

Time of onset and offset of late dips, were longer in the hypoxic group than in the two cephalopelvic disproportion groups, which were similar. Times of onset and offset were least in the control group.

The amplitude followed a similar trend to duration, but in all cases, lay between 20 and 40, compared with Beard's series, (Beard 1971) where the amplitude of late decelerations, rarely exceeded 20 beats per

TABLE 21

EARLY DECELERATIONS

		Hours before delivery 4th	3rd	2nd	1st
Mean time of onset of deceleration (in secs). after onset of the contraction	Major CPD Group	1.7	0	5.0	1.6
	Minor CPD Group	0	0	1.7	5.0
	Control	0	1.7	4.7	3.6
	Hypoxic			0	0
Mean time of completion of deceleration (in secs). before completion of the contraction	Major CPD Group	1.2	5.4	4.7	6.2
	Minor CPD Group	0	8.7	2.5	8.9
	Control	0	1.7	5.0	4.2
	Hypoxic			0	0
Mean duration of deceleration (in secs).	Major CPD Group	39	41	47	50
	Minor CPD Group	42	40	45	46
	Control	39	40	39	42
	Hypoxic			56	54
Mean amplitude of deceleration (in beats).	Major CPD Group	26	29	34	36
	Minor CPD Group	20	27	19	27
	Control	0	23	29	33
	Hypoxic			20	40

TABLE 22

EARLY PROLONGED DECELERATIONS

	GROUP	Hours before delivery			
		4th	3rd	2nd	1st
Mean time of onset of deceleration (in secs.) after onset of the contraction	Major CPD	0	1	1	2
	Minor CPD	0	0	2	0
Mean time of completion of deceleration(in secs.) after completion of the contraction	Major CPD	17	26	30	31
	Minor CPD	18	20	29.3	25.6
Mean duration of deceleration (in secs.)	Major CPD	70	77	79	82
	Minor CPD	67	71	78	78
Mean amplitude of deceleration (in beats)	Major CPD	28	35	40	38
	Minor CPD	30	33	30	29

TABLE 23

LATE DECELERATIONS

	GROUP	Hours before delivery 4th	3rd	2nd	1st
Mean time of onset of deceleration (in secs.)after onset of the contraction	Major CPD	24.0	26	26	26
	Minor CPD	22	21	24	28
	Control	12	10	20	27
	Hypoxic	-	-	31	32
Mean time of completion of deceleration (in secs.) after completion of the contraction	Major CPD	29	36	31	37
	Minor CPD	30	33	35	35
	Control	16	18	22	20
	Hypoxic	-	-	41	46
Mean duration of the deceleration (in secs.)	Major CPD	62	67	70	69
	Minor CPD	61	65	66	68
	Control	59	65	60	58
	Hypoxic	-	-	74	76
Mean amplitude of the deceleration (in beats)	Major CPD	32	35	36	40
	Minor CPD	30	30	35	39
	Control	21	20	26	40
	Hypoxic	-	-	40	41
Time lag(in secs) A = < 10 secs. B = 10→30 " C = > 30 "	Major CPD	A - 8% B - 64% C - 28%	A - 7% B - 84% C - 9%	A - 14% B - 75% C - 11%	A - 9% B - 72% C - 19%
	Minor CPD	A - 0% B - 85% C - 15%	A - 3% B - 69% C - 28%	A - 0% B - 80% C - 20%	A - 3% B - 60% C - 47%
	Control	A - 5% B - 90% C - 5%	A- 6% B -84% C- 10%	A - 4% B - 80% C - 16%	A - 7% B - 72% C - 11%
	Hypoxic	-	-	A - 7% B - 64% C - 29%	A - 12% B - 60% C - 28%

minute.

Apart from the fact that the predominant time lag throughout was between 10 and 30 seconds, no clear trend emerged.

The pHs throughout (Figure 14), showed a downward trend as labour progressed and were lowest in the hypoxic group followed in turn by the major cephalopelvic disproportion group and the minor disproportion group, with the control group least acidotic. The cord pHs related closely to the Apgar scores (Table 24).

FIG. 14
MEAN pH OF FETAL AND CORD BLOOD

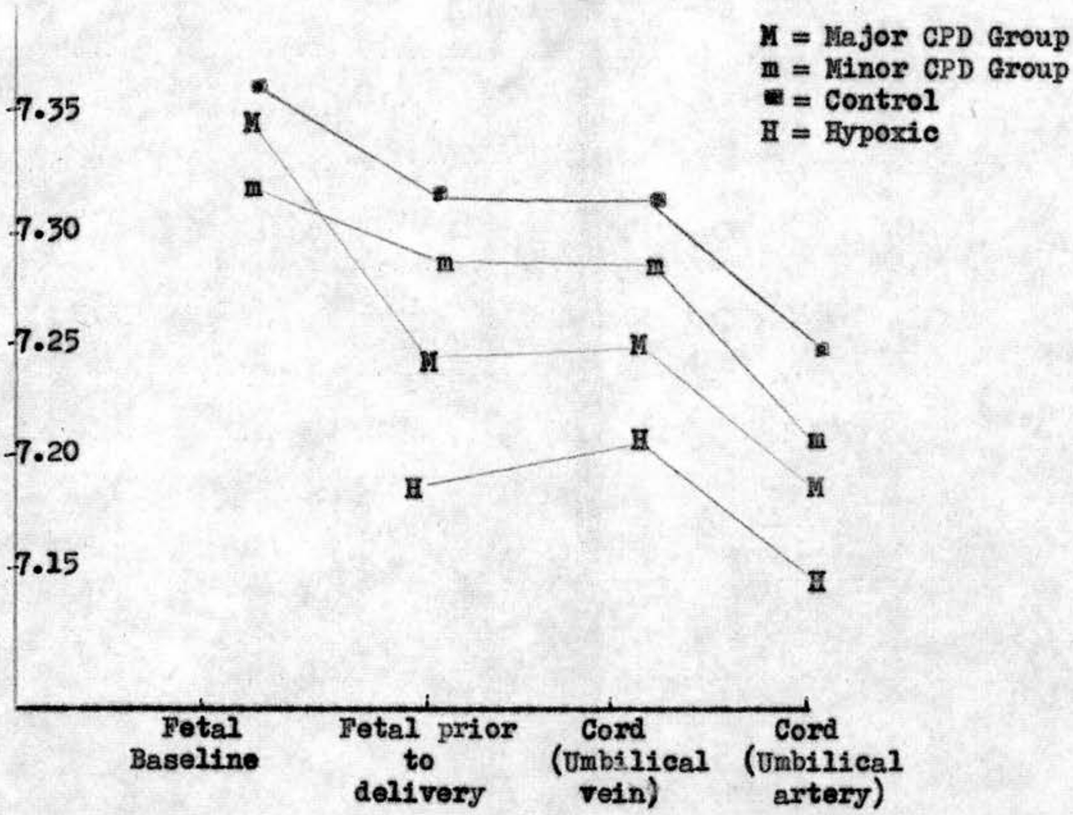


TABLE 24
MEAN APGAR SCORES

	Apgar at 1 min.	Apgar at 5 mins.
Major CPD Group	6.7	9.5
Minor CPD Group	7.8	9.9
Uterine dysfunction Group	8.6	9.9
Control Group	8.8	9.9
Hypoxic Group	4.4	7.6

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 14

MEAN pHs OF FETAL & CORD BLOOD

	Fetal Baseline pH	Fetal pH prior to Delivery	Umbilical vein pH	Umbilical artery pH
Major CPD Group	7.34	7.24	7.25	7.20
Minor CPD Group	7.32	7.28	7.29	7.22
Control Group	7.36	7.32	7.32	7.26
Hypoxic Group	-	7.19	7.21	7.14

DISCUSSION

It has been generally accepted for some years that the early dips of Hon and Quilligan (1967), or the Type 1 dips of Caldeyro et al (1966) are associated with physiological head compression occurring in normal labour. Late or Type 2 dips occur where there is a fetal hypoxia. (Kubli, 1969)(Hon and Khazin, 1969)(Hon and Quilligan, 1968)(Beard et al, 1971).

In the cephalopelvic disproportion groups here investigated, a third type of fetal heart rate dip has emerged. Major and minor cephalopelvic disproportion respectively were the sole abnormal influencing factors present. Although controlled Syntocinon augmentation was used, this as demonstrated by Weaver et al (1974) has no effect on the fetal heart rate pattern, nor has the correct use of continuous epidural analgesia (Moir, 1971).

In the presence of the increased head compression encountered in cephalopelvic disproportion, the fetus responds with an early prolonged dip as displayed in Figures 8, 9 and 13, and as depicted in Plate 24. The deceleration starts early with no time lag between the lowest point of deceleration and the peak of the contraction, and returns to a base line rate, late in relation to the end of the contraction. These decelerations become more pronounced with the duration of labour and are more marked, the greater the degree of disproportion.

A similar type of fetal heart rate dip has been reported by Mocsarry et al (1970). During investigations carried out on hydrocephalic, non viable, full term fetuses during labour the intra-cranial pressure was artificially increased by intra ventricular injection of physiological saline. A fetal heart rate response as depicted in Figure 15 was obtained. Walker et al (1973)(Figure 16) by applying

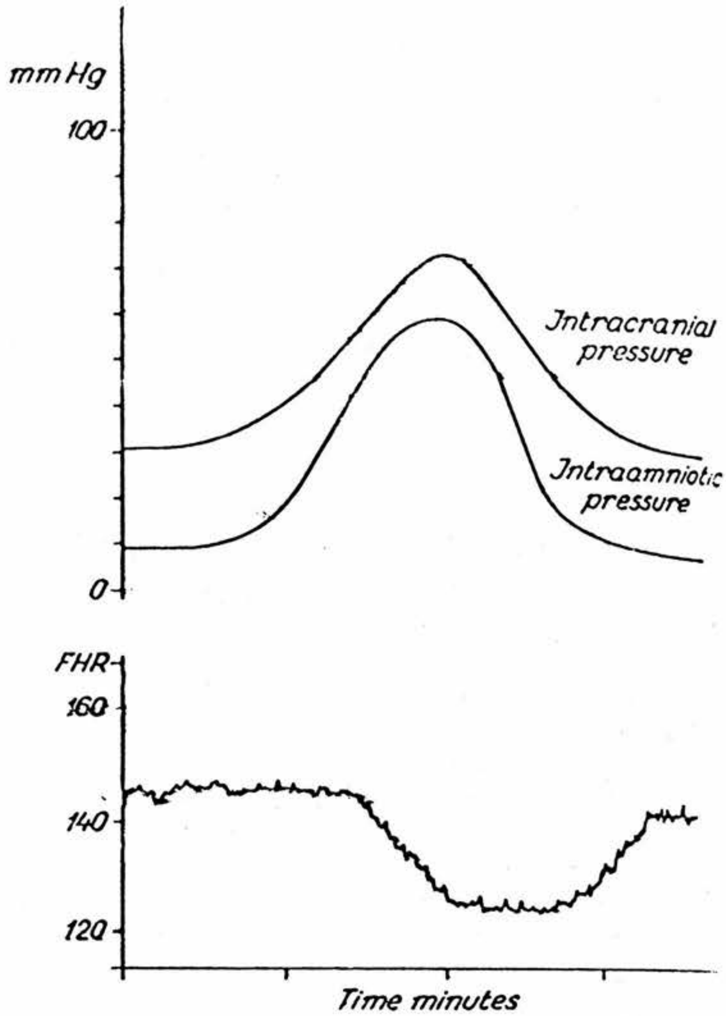


FIGURE 15. Response to increased intra-cranial pressure.

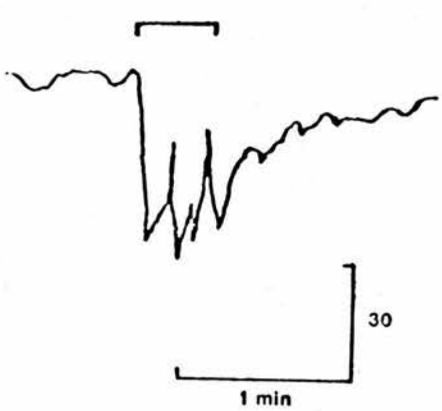


FIGURE 16. Response to external head pressure.

pressure for 20-40 seconds suprapubically to the maternal abdomen and thence to the fetal skull, causing a rise in intra-amniotic pressure to approximately 100 mms.Hg, produced a bradycardia showing slow recovery.

As labour progresses in the presence of cephalopelvic disproportion, the fetus, in addition to exhibiting prolonged early dips, shows a tendency to tachycardia and flattening of beat-to-beat variation. It also develops to an increasing degree the classical late decelerations and falling pH (Figs. 12 & 14) of hypoxia. It would appear that these changes with the addition of first, the slow return of fetal heart rate to the base line, differentiating the prolonged early from the early dip, and then the development of late dips, indicate an increasing depression of the autonomic and cardio-vascular reflexes, as the physical condition of the fetus deteriorates.

The exact cause of the bradycardia is difficult to determine, though it is generally agreed to be a vagal response (Bradfield, 1961). Mechanisms which have been suggested, include excitation of the vagal centre by increased intra cranial pressure per se, (Mocsarry P et al, 1970) neural hypoxia resulting from decreased cranial perfusion (Paul, 1964) and by a circulation reflex involving the carotid body. (Bradfield 1961).

This information can be usefully applied to clinical practice. Expensive monitoring equipment is not necessary. As later discussed sequential count clinical auscultation, or fetal heart rate recording using the method of Steer and Beard (1970), can detect and classify fetal heart rate dips. In conjunction with the other clinical features considered in this investigation in the management of Oxytocin augmented Trial of Labour, the fetal heart rate pattern, just described can be more meaningfully recognised and applied to set safety limits to the Trial of Labour.

THE SIGNIFICANCE OF CLINICAL FEATURES IN TRIAL OF LABOUR

THE SIGNIFICANCE OF CLINICAL FEATURES IN TRIAL OF LABOUR

In this Section, the various clinical parameters observed during labour have been examined. The use of Oxytocin, the rate of cervical dilatation, the rate of head descent, the pattern of moulding, the mechanism of labour, the pattern of caput formation and the presence or absence of meconium, are discussed.

OXYTOCIN USED.

The details of the use of Oxytocin, are displayed in Table 25. In all instances, the Oxytocin infusion was closely supervised and aimed to produce a contraction pattern of between three and four per ten minutes. The Oxytocin infusion was reduced immediately should the contractions occur more frequently than this.

The mean amount of Oxytocin used in the major cephalopelvic dispro-:portion group, was only 3.31 m Units per minute (i.e. 1 unit of Oxytocin per litre of 5% Dextrose run in at about forty-five drops per minute). In the minor group, the mean concentration used was 5.02 m Units per minute, and in the primary uterine dysfunction group, the mean concentra-:tion was 3.55 m Units per minute.

Small amounts only of Oxytocin therefore were required, particularly in the major cephalopelvic disproportion group. Similarly, this group reacted most quickly to the Oxytocin infusion - by a mean of twenty minutes after commencing the infusion, a satisfactory contraction pattern had been established - and proved most "brittle". In 26% of the cases in the major cephalopelvic disproportion group, the Oxytocin had to be reduced because of excessive uterine activity as compared to 19% in the minor group and none in the primary dysfunctional group.

Plate 25 demonstrates the speed of uterine response to the Oxytocin infusion in a case where there proved to be major cephalopelvic dispro-:portion present.

DISCUSSION

Plate 25 highlights the importance of adequate supervision and readiness to reduce the concentration of Oxytocin.

An Oxytocin infusion should never be used unless its commencement can be supervised by a doctor and its continuation by a reliable nurse.

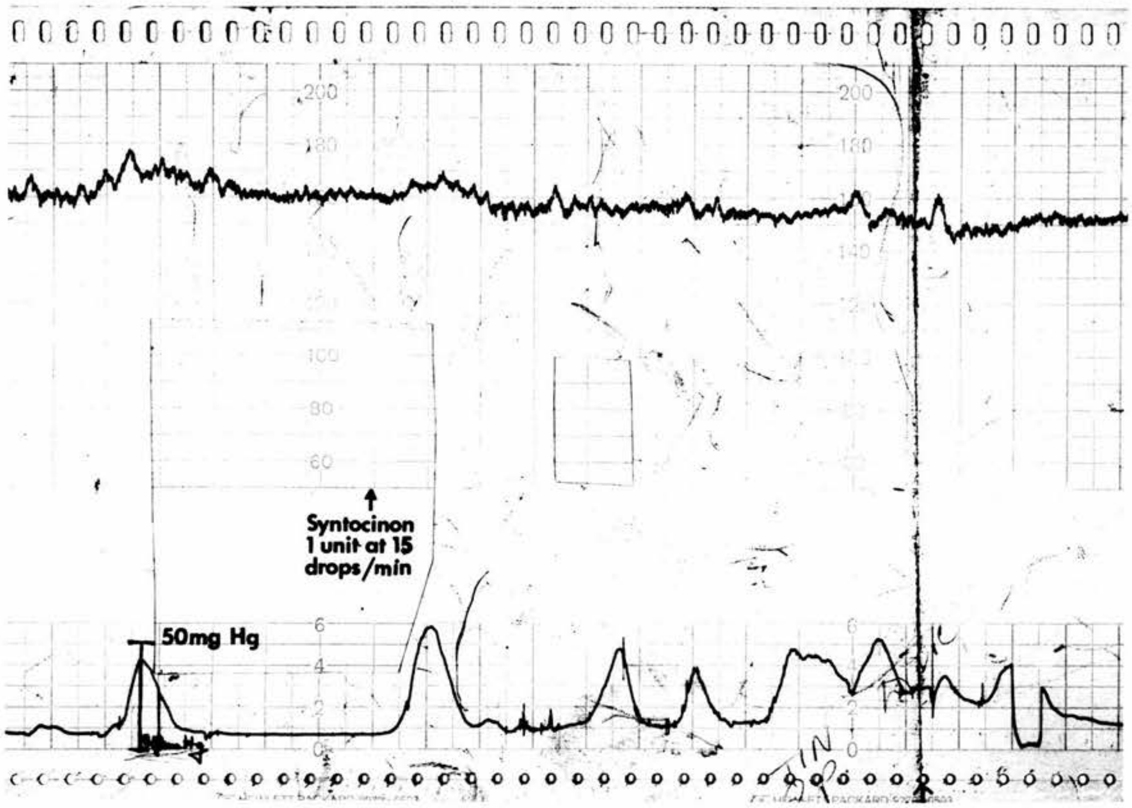


PLATE 25. Uterine response to Oxytocin.

As shown in Table 25, less Oxytocin was used and for a shorter time in the major cephalopelvic disproportion group, than in the minor group - not only as regards the length of time the Oxytocin was given but also, only 70% of the concentration was used in the major group compared to the minor. In the major group, the contractions were created more readily and with smaller doses, than in the minor.

The amount and duration of Oxytocin used, were similar in the major cephalopelvic disproportion and primary uterine dysfunction groups! In the dysfunctional group, little extra Oxytocin was required to stimulate the uterus to activity; in the disproportion group, on the other hand, less Oxytocin was permitted by the uterus!

With these two groups, the answer to augmented Trial of Labour was available by a mean of four hours. On the one hand, there were indications for delivery; on the other, the patient was delivered. In the minor cephalopelvic disproportion group, by four hours, it was becoming apparent that the patient would progress to a vaginal delivery.

TABLE 25

OXYTOCIN AUGMENTATION

	MAJOR CPD (50 cases)	MINOR CPD (21 cases)	PRIMARY INERTIA (11 cases)
Mean Interval in hours Oxytocin → Onset of contractions	0.3	1	0.4
Mean hours for which Oxytocin used	3.98	5.08	3.66
Mean Total amount of Oxytocin used (m Units)	792.27	1630.62	781.66
Mean Oxytocin dosage in m Units/minute	3.31	5.02	3.55
% of cases requiring Oxytocin reduction	26%	19%	0%

EPIDURAL BLOCK

All patients in the dysfunctional groups were given an epidural analgesic during the first stage of labour. The t echnique described (Page 60), was followed. Caesarean Section was carried out under the same epidural block.

RESULTS

Efficacy - 90% of the patients were fully satisfied with the pain relief afforded. In 8%, the pain was relieved, but only partially. The main problem was that of the unblocked segment, described by Ducrow (1972). In two cases, for no obvious r eason, the epidural anaesthesia failed to have any effect, despite recatheterisation and a fairly certain placing of the catheter in the epidural space.

Fifty seven of the Caesarean Sections were carried out uneventfully with no patient distress. In six cases, however, further local skin infiltration with anaesthetic was required. In three cases, this did not suffice and intravenous "Ketalar" along with "Valium", was used.

In general the epidural acted within ten minutes (Plate 20). The mean duration of relief by top up, was two and a half hours and the upper-:most limit of the block reached was T7.

COMPLICATION RATE

Dural tap occurred in only one case where in fact analgesia was obtained following recatheterisation at the adjacent inter-vertebral space. There were no subsequent side effects. A "bloody tap" occurred in eleven cases at the initial insertion of the catheter and in a further six cases, blood was found to have tracked back up the epidural catheter during labour. On three occasions, clotted blood caused the catheter to block and repeat catheterisation was required at the adjacent space.

Hypotension, defined (Crawford, 1972), as a fall of systolic blood pressure in excess of 10 mmsHg. within twenty minutes, occurred in only one case, where the blood pressure dropped to 100/60 from 130/80, with no ill effects.

DISCUSSION

In all cases, the epidural block was administered by the author, an Obstetrician who had had little experience in the technique prior to working in Harari Hospital. The procedure, carried out with close attention to the proper technique, was found to be straightforward and certainly within the capabilities of most doctors correctly supervised over a short initial period. Given this introductory training, plus the ability to intubate and resuscitate a patient should the necessity arise, the satisfactory results obtained in this study suggest that epidural analgesia is by no means the anaesthetist's prerogative !

The benefits to the patient were obvious and necessary. After in some cases hours of uncertainty and fear, she was relieved of discomfort and distress and augmentation of labour was made possible. If Caesarean Section became indicated, no further anaesthetic procedure was required and the patient was saved from what, in a large number of cases, was her greatest fear - that of being anaesthetised.

Accuracy in clinical observation was greatly improved. The con:traction and fetal heart rate patterns, the head level, cervical dilatation and amount of moulding present, were all much more accurately established without causing patient distress.

The most troublesome complicating feature was the "bloody tap", indicating puncture of an epidural blood vessel. This problem occurred more commonly in this series, than elsewhere reported, presumably because of the greater vascular engorgement of the epidural space in the prolonged labour with cephalopelvic disproportion present. The procedure followed when blood had tracked back up the catheter, was always, as suggested by Crawford (1972) to inject 3 ccs. of 1% "Lignocaine" as a test dose to safely establish that the injection was not intravascular before introducing the "Marcaine". On no occasion were there untoward effects.

CERVICAL DILATATION AND HEAD LEVEL

CERVICAL DILATATION - RESULTS

Figure 17 displays the mean trends of cervical dilatation at progressive points in labour, in the different groups.

Table 26 shows the mean rates of cervical dilatation in the control groups and in the dysfunctional labour groups both before and after Oxytocin.

In the control group, the mean cervical dilatation on admission, was just less than 5 cms., and the mean rate of dilatation thereafter, was 1.3 cm. per hour. Two hours before delivery, the mean cervical dilatation was 7.7 cms.

At the Oxytocin commencement point, the highest mean cervical dilatation was 6.6 cms. in the primary dysfunction group which was significantly greater ($p \leq 0.01$) than the 4.9 cms. of the major disproportion group, or the 5.7 cms. of the minor group ($p \leq 0.05$). The mean cervical dilatation at the point of delivery in the major group was 6.4 cms.

From Table 26, the rate of cervical dilatation was similar in the minor disproportion and dysfunctional labour groups - each although slow at about 0.25 cms. per hour, was twice the rate found in the major group ($p < 0.01$). Oxytocin augmentation most stimulated the rate of cervical dilatation in the primary dysfunctional group at 1.17 cms. per hour, which was significantly faster ($p < 0.05$) compared to the minor group and the 0.34 cms. per hour ($p < 0.001$) of the major group. The ratio of accelerated dilatation in the three groups, was approximately 5:4:3.

HEAD LEVEL - RESULTS

In Figure 18, the head levels in fifths, are displayed.

At the Action Line, the head level in the major and minor disproportion groups, were similar, and each was significantly higher ($p < 0.01$) than in the primary dysfunction group. At two hours before delivery, the mean head levels in the control, the dysfunctional and the minor disproportion groups had become virtually the same. The major group head level however was obviously higher ($p < 0.01$) and remained so until delivery. The mean level in the minor disproportion group at delivery was 1.8 fifths ($p < 0.01$) above as compared to one fifth in the control and primary inertia group.

DISCUSSION

Of the three parameters for assessing progress of labour in the primigravida, the rate of cervical dilatation, the rate of head descent and the pattern of uterine contraction, the first in the primigravida is the most valuable. The results in this series demonstrate that the primary uterine inertia group showed the highest mean cervical dilatation at the Action Line. The cervical dilatation response to oxytocin infusion was greatest where there was least cephalopelvic disproportion. The results compare with those of Philpott and Castle (1972) and agree with the findings of Friedman (1965) that the rate of cervical progression after arrest is of considerable prognostic value. Of interest was the fact that the mean cervical dilatation in the major cephalopelvic disproportion group at time of delivery was 6.4 cms.

Throughout, the head remained highest in the major cephalopelvic disproportion group, and it was only in the last two hours before delivery that either the head descended or remained stationary as in the major cephalopelvic disproportion group, at 3.5 fifths above - that is generally between two and four hours following commencement of the oxytocin augmentation. Prognostically therefore, the rate of head descent was not nearly so important in the early stages of labour as was the rate of cervical dilatation.

Accurate knowledge of head level, as will be discussed later, was however, of paramount importance in deciding the mode of delivery.

FIG. 17

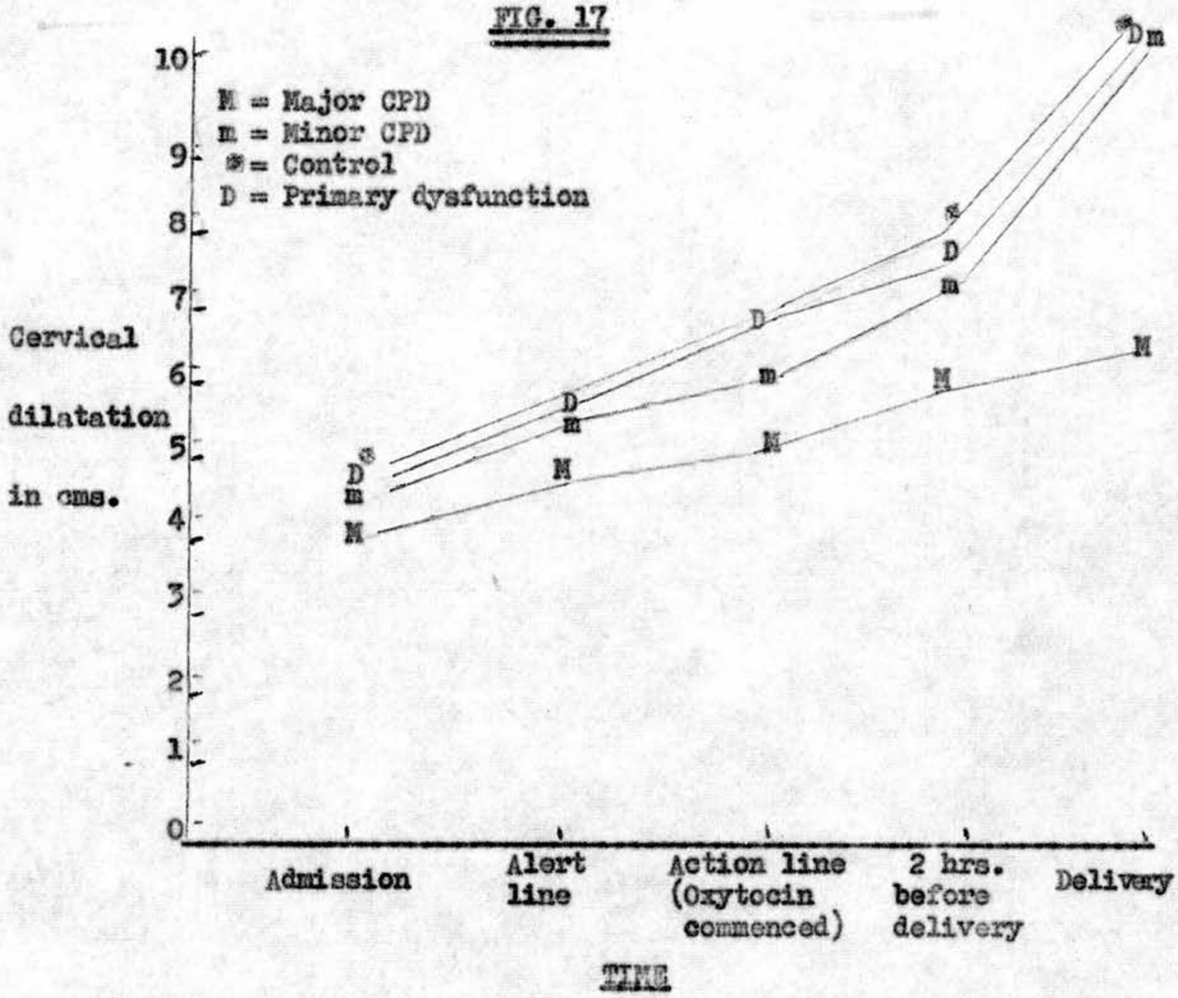


TABLE 26

	Mean cervical dilatation in cms./hour Admission → Oxytocin commencement	Mean cervical dilatation in cms./hour Oxytocin → Delivery
Major CPD	0.11	0.34
Minor CPD	0.25	0.92
Primary Dysfunctional Labour	0.22	1.17

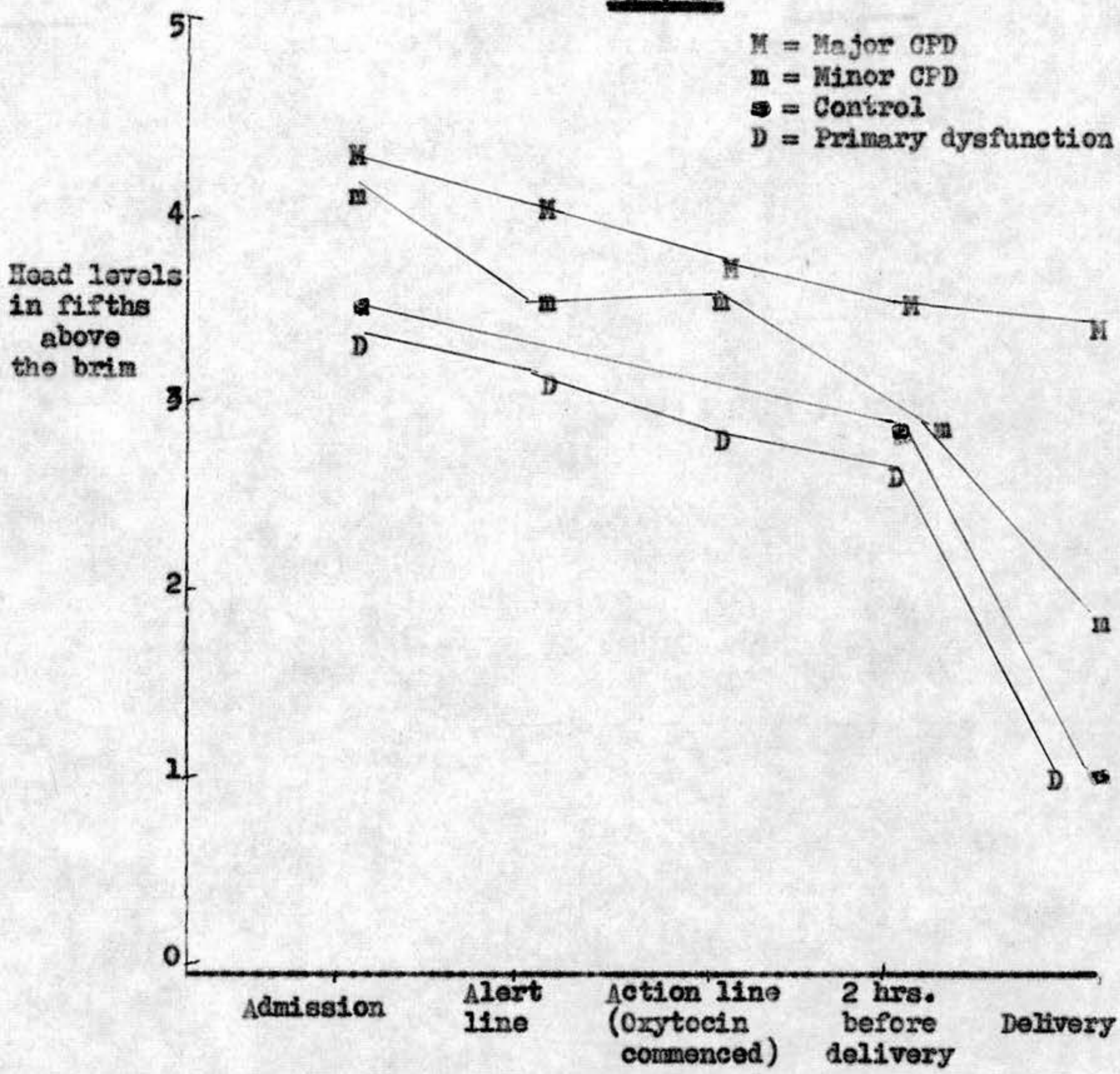
Control Group - Cervical dilatation in cms./hour. Admission → Delivery 1.30

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 17

CERVICAL DILATATION

	Admission	Alert Line	Action Line (Oxytocin commenced)	2 hours before delivery	Delivery
Major CPD Group	3.9	4.7	4.9	6.0	6.4
Minor CPD Group	4.3	5.2	5.7	7.2	10.0
Control Group	4.7	-	-	7.7	10.0
Primary Dysfunction Group	4.4	5.5	6.6	7.3	10.0

FIG. 18



TIME

TABLE 27

MOULDING SCORE AND HEAD AREA DIFFERENCES

	Major CPD	Minor CPD	Uterine Dysfunction	Control
Mean fetal moulding score at delivery (P.O.+P.P. inpluses)	5.9	4.6	3.5	3.0
Mean head area differences, days 5 to 1 (sq. cms.)	5.0	3.8	2.6	2.5

SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 18

MEAN HEAD LEVELS

	Admission	Alert Line	Action Line (Oxytocin commenced)	2 hours before delivery	Delivery
Major CPD Group	4.3	4.0	3.8	3.6	3.5
Minor CPD Group	4.1	3.6	3.6	2.8	1.8
Control Group	3.6	-	-	2.8	1.0
Primary Dysfunction Group	3.3	3.1	2.7	2.6	1.0

MOULDING OF THE HEAD

During labour and delivery, the fetal head particularly in the presence of cephalopelvic disproportion, moulds in response to the considerable stresses to which it is subjected. Hitherto, clinical description of moulding, as marked, moderate or slight, has been vague and without real meaning.

Moulding however, is a most important event in labour and requires accurate documentation. Excessive and dangerous head compression wich may occur in disproportion, will be reflected by an excessive degree of moulding which therefore should be regarded as a sign of fetal distress. In the presence of disproportion, increasing moulding with a continuing high head, will signal impending obstructed labour. Again, taken with head level and other features to be discussed later, the amount of moulding in the second stage of labour, should be used to determine the appropriate mode of delivery.

For these reasons, it was considered necessary to quantitate moulding as a precise objective score. To define its degree, the moulding was graded as shown in Figure 1 (Page 57) and described relative to the parietal/occipital and parietal/parietal suture lines. The pluses were added together to provide a score.

The scoring method was then examined to determine its accuracy; to describe the pattern of moulding; and finally to assess the significance of the moulding score obtained.

RESULTS

The fetal moulding score immediately before delivery was compared against the reduction in presenting head areas achieved by moulding.

This was quantitated in retrospect by measuring the baby's biparietal and suboccipito bregmatic diameters at delivery and five days post-partum, when moulding had subsided. The head areas were calculated and the difference in head area between the fifth day and following delivery determined. Table 27 shows that the differences in moulding score before delivery in the groups, did correspond with the different reductions in head area due to moulding. Thus the objective method of assessing moulding, would seem to be accurate and reproducible.

Figure 19 shows the pattern and degree of moulding in the different groups at different times of labour.

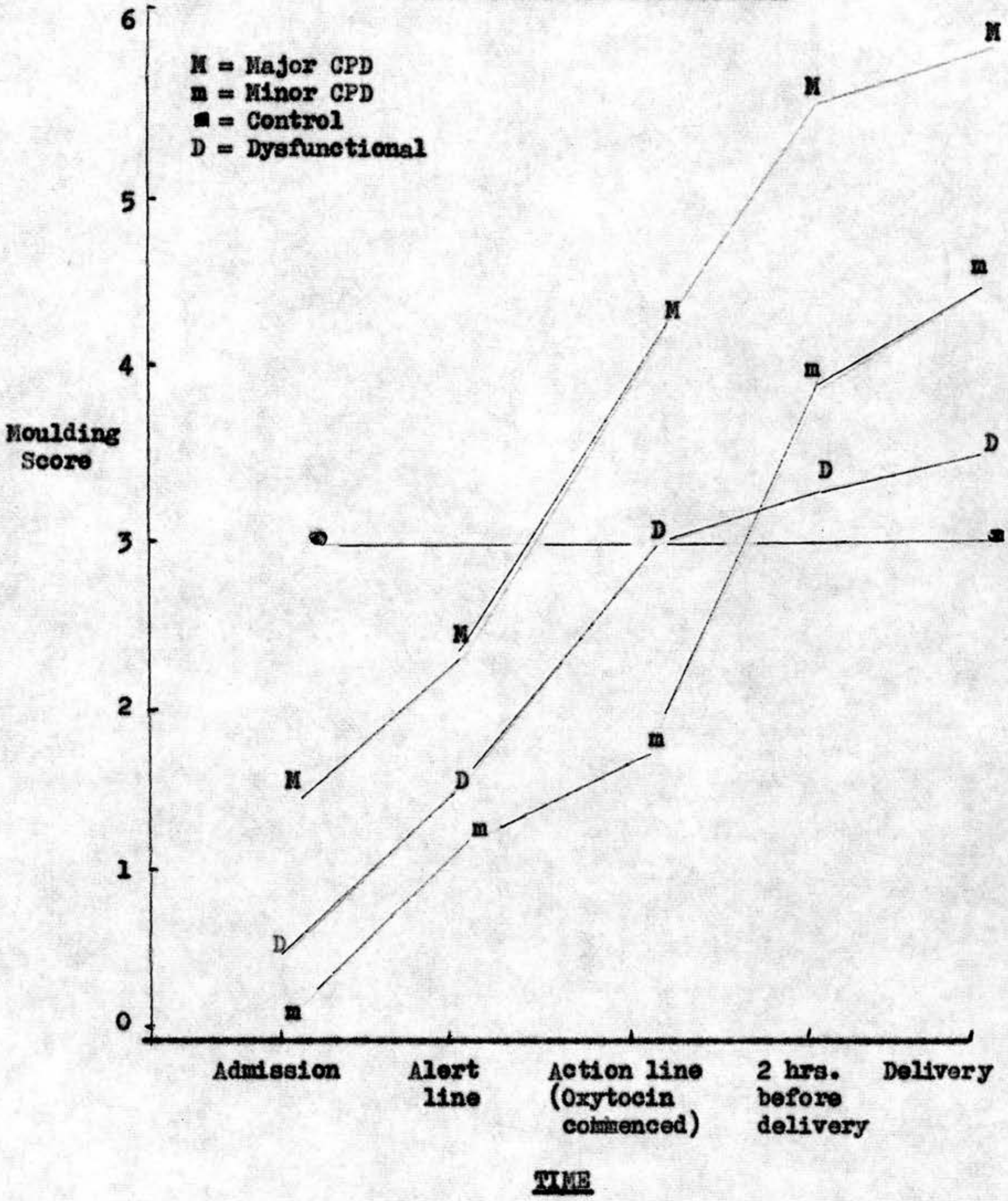
The moulding was greater on admission in the control group than in the other groups - attributable presumably to the fact that the patients were well established in labour on admission. The moulding however stayed virtually the same throughout labour.

stayed

The highest moulding score was found in the major disproportion group immediately prior to delivery with the findings two hours before only slightly less. Over these two hours, there was virtually no head descent. At the same time, moulding was less on admission, and at the Alert Line than in the control group, but by the Action Line, the major group showed more moulding than did the controls. This moulding increased to the time of delivery.

The minor cephalopelvic disproportion group throughout showed less moulding than the major group and initially less than the primary uterine dysfunction group and controls. With strong uterine contractions and progress in labour, moulding exceeded that present in these two groups and by time of delivery was second to the major group in extent.

FIG. 19
MOULDING SCORES DURING LABOUR



SUPPLEMENTARY TABLE TO ACCOMPANY FIG. 19

MEAN MOULDING SCORES DURING LABOUR

	Admission	Alert Line	Action Line (Oxytocin commenced)	2 hours before delivery	Delivery
Major CPD Group	1.5	2.2	4.2	5.8	5.9
Minor CPD Group	0.2	1.3	1.8	3.9	4.6
Control Group	3.0	-	-	3.0	3.0
Primary Dysfunction Group	0.6	1.6	3.0	3.4	3.5

The moulding pattern in the primary dysfunctional group, came to closely resemble that in the control group, although initially, as with the two disproportion groups on admission there was less moulding than in the control group.

Relating the degree of moulding to the level of the head above the brim, shows that on admission, the moulding was greater in the controls (head level 3.6) as compared to the major group (head level 4.3 fifths) and as compared to the minor cephalopelvic disproportion group (head level 4.1 fifths). In the major cephalopelvic disproportion group, the head level at time of delivery had become the same as that on admission of the control group (3 + fifths above), but with a much greater degree of moulding. From the findings, can be seen an association between head level and degree of moulding.

In Table 28 throughout moulding at the parietal/occipital suture line preceded and was more marked than that at the parietal/parietal. Examination of the infant's head following birth (Table 29) showed the moulding to be most marked at the parietal/occipital suture line, followed in turn by the parietal/frontal and parietal/parietal suture lines. Presumably therefore, had all suture lines been palpable in labour, this too would have been the sequence of moulding.

The results acceptably suggest that only two sutures need be palpated to give a guide as to the degree of moulding present - that is, if the head if well flexed, the parietal/occipital and parietal/parietal suture lines; if deflexed, the parietal/parietal and parietal/frontal suture lines.

TABLE 28

FETAL MOULDING PRIOR TO DELIVERY

GROUP	P.O. Moulding	P.P. Moulding	Moulding Index (P.O. + P.P.)
Major CPD	2.95	2.91	5.86
Minor CPD	2.69	1.92	4.61
Primary Dysfunctional Labour	2. 1	1. 4	3. 5
Control	1.93	1.07	3.0

TABLE 29

BABY MOULDING FOLLOWING DELIVERY

GROUP	P.O.	P.P.	P.F.
Major CPD	2.85	2.65	2.69
Minor CPD	2.76	2.14	2.56
Primary Dysfunctional Labour	2.16	1.14	1.57
Control	1. 9	1.03	1.27

DISCUSSION

From these observations, it can be said that the amount of moulding is dependent on efficient labour, on the level of the head and on the degree of disproportion present. Moulding is also dependent on the mouldability of the head, although in this study where there was neither prematurity nor postmaturity, this variable was not present.

Because of failure to progress, with no descent of the head in the major cephalopelvic disproportion group, despite strong contractions, the presence of three pluses of moulding at each of the parietal/occipital and parietal/parietal suture lines, should be regarded as signifying marked moulding. If persisting two hours later with no descent of the head, then the moulding is becoming excessive and on its own account, must be regarded as a sign of fetal distress.

THE MECHANISM OF LABOUR

Tables 30 and 31, demonstrate the degrees of flexion and the vertex positions in the different groups at different stages of labour. The head was well flexed in 91% of the cases in the major disproportion group on admission, with an even higher percentage at the point of delivery. In the control group, only 62.1% were well flexed on admission but this percentage had risen to 87% by time of delivery.

The position of the vertex was predominantly transverse.

Caldwell and Moloy (1933) found that 60% of the fetuses entered the pelvic inlet in a transverse position. This relates more closely to the control group in the series here reported. In the major cephalopelvic disproportion group, the incidence was higher. In addition the marked increase in flexion of the head as compared to the control group, reflected an exaggeration of the normal flexion adopted by the fetal head in the small gynaecoid pelvis.

When the head is wellflexed and in a favourable position, if there is no progress in the labour, then prognosis for a vaginal delivery is poor: that is, there has been failure to progress in the most advantageous position.

TABLE 30

HEAD FLEXION

(% OF HEADS WHICH WERE WELL FLEXED)

	Major CPD Group	Minor CPD Group	Control Group	Primary Dysfunction Group
Admission	91 %	76.5%	62.1%	70%
Action line	92.1%	84.2%	-	70%
Second stage	93.3%	85.7%	87.1%	86%

TABLE 31

HEAD POSITIONS

(% OF VERTEX IN TRANSVERSE POSITIONS (2,3,4,8,9,10 o'clock)

	Major CPD Group	Minor CBD Group	Control Group	Primary Dysfunction Group
Admission	93.4%	64.7%	100 %	66.7%
Action line	85.8%	76 %	-	83.4%
Second stage	88.8%	65 %	73 %	83.4%

CAPUT FORMATION

This was measured subjectively as discussed on Page 54, and was described as cervical or pelvic. As displayed by Table 32, the degree of caput formation was more closely related to the duration of labour rather than to the degree of disproportion present. The amount of caput present in the primary dysfunctional labour group was much closer to that in the major disproportion group, than to the control - a reverse of the situation with moulding. The control group where duration of labour was almost half of that in the other groups, had less than half of the degree of caput formation. At the same time however, there was a similar trend with moulding and degree of cephalopelvic disproportion.

The type of caput was of importance. In 12% of the major dis-: proportion cases, the caput was pelvic and demarcated by the bony pelvic brim rather than by the cervical lip.

DISCUSSION

Although subjectively measured, the degree of caput was fairly reliably assessed clinically. There was some correlation with degree of cephalopelvic disproportion and in addition the presence of pelvic caput had particular significance.

Cervical caput also had some prognostic value, where, as occasionally occurred, the moulding situation was uncertain. There was, for example, a marked caput formation in one case where with the head, five fifths above the brim, moulding had not properly formed. The patient proved to have marked cephalopelvic disproportion.

TABLE 32

CAPUT FORMATION

GROUP	Mean Pluses of Caput	Mean Mento Vertico Diameter differences Days 5-1 (in cms.)	Mean Duration of Labour/in hrs.
Major CPD	2.02	1.6	25.6
Minor CPD	1. 9	1.6	25.9
Primary Dysfunctional Labour	1. 7	1.4	22.5
Control	0. 8	0.7	12.7

TABLE 33

% OF CASES WITH MECONIUM

GROUP	Admission	Action line (Oxytocin commenced)	Delivery
Major CPD	32%	34%	57%
Minor CPD	40%	40%	50%
Uterine Dysfunction	18%	22%	22%
Control	17%	-	17%

MECONIUM

LIQUOR

From Table 33, 17% of the control group had meconium staining of the liquor at delivery. Of these all had meconium on admission. There were no fresh developments of meconium in labour, nor was there retrospective explanation for the development of meconium.

In the other groups, on admission, meconium was present in a high percentage in the major cephalopelvic disproportion group (32%), and also, in this group a higher number developed fresh meconium in labour giving an incidence at delivery of 57%. In the minor cephalopelvic dis:proportion group, 40% had meconium on admission and 50% at delivery. The incidences in the primary inertia group were similar to those of the control group.

DISCUSSION.

Understanding of the significance of meconium staining of the liquor is limited. Some consider that the presence of meconium per se is a poor reflection of fetal acid base balance (Colthart , 1969), Motelewitz , 1973), (Schultze, 1925) and (McColl, 1953). Others regard meconium as an adverse sign, (Lister and Buchanan, 1957); (Fitzgerald and McFarlane, 1955). The incidence of meconium staining of the liquor, of 17% found in the control group presented here, was higher than that of the 6.7% found by Barhan, (1969) who carried out amnioscopy on 1,000 patients, and the 6% found by Lesley, (1959), following Artificial Rupture of Membranes in 2,054 patients.

Of significance in this investigation was the absence of further developments in meconium in the control group as compared to the other groups where fresh meconium appeared in labour.

In the presence of major cephalopelvic disproportion and in the absence of other abnormalities, meconium was present in 57% of cases. It would seem probable that this development was the result of an autonomic impulse in the presence of head compression.

Meconium developing in prolonged labour should therefore be taken into consideration as an additional index as to the degree of cephalopelvic disproportion present.

ACCURACY OF CLINICAL MONITORING

ACCURACY OF CLINICAL MONITORING

In the majority of small African Hospitals, limited resources mean that clinical observation alone without the extra aids from sophisticated equipment, must be relied on. In this study therefore, clinical monitoring was checked against scientifically based observation to assess its accuracy. The uterine contractions and fetal heart rate were monitored electronically, the head level was assessed radiologically and the results compared against the clinical measurements. Reliable information was obtained on all three counts, clinically.

UTERINE CONTRACTIONS.

Measurement of the uterine contraction pattern is always important but becomes particularly so, when Oxytocin is being used and in determining the type of fetal heart rate deceleration present.

Until recently, the custom has been to use the terms "strong", "medium" or "weak", depending purely on a subjective and therefore individually variable impression. The method as used here (Plate 8) of clinically timing the actual contraction was first introduced by Eskes (1962) and modified by Philpott.

To check the accuracy of clinical observation, the contractions were timed by both an observer and the patient and compared against the actual rise in uterine pressure as displayed on the cardiotocograph. Plate 26 shows an example of the exact duration of the contraction; when it was noted by the clinical attendant; and when it was appreciated by the patient. It was found that the first and last five seconds of the actual contraction were not recognised by the attendant who did, however, detect the contraction before the patient. Pain was experienced by the patient when the contraction was well established and the pressure

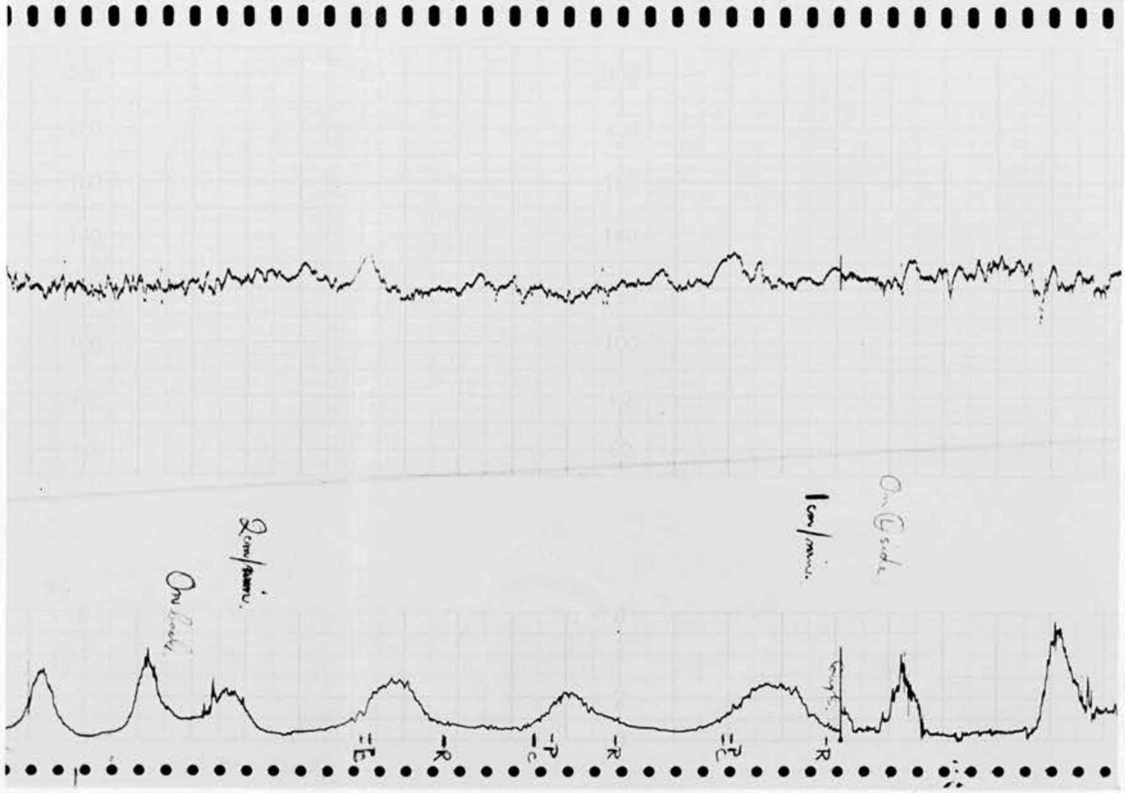


PLATE 26. Contractions on the Tocograph trace.

C = Contraction noted by observer P = Contraction noted by patient
R = Relaxation noted by observer.

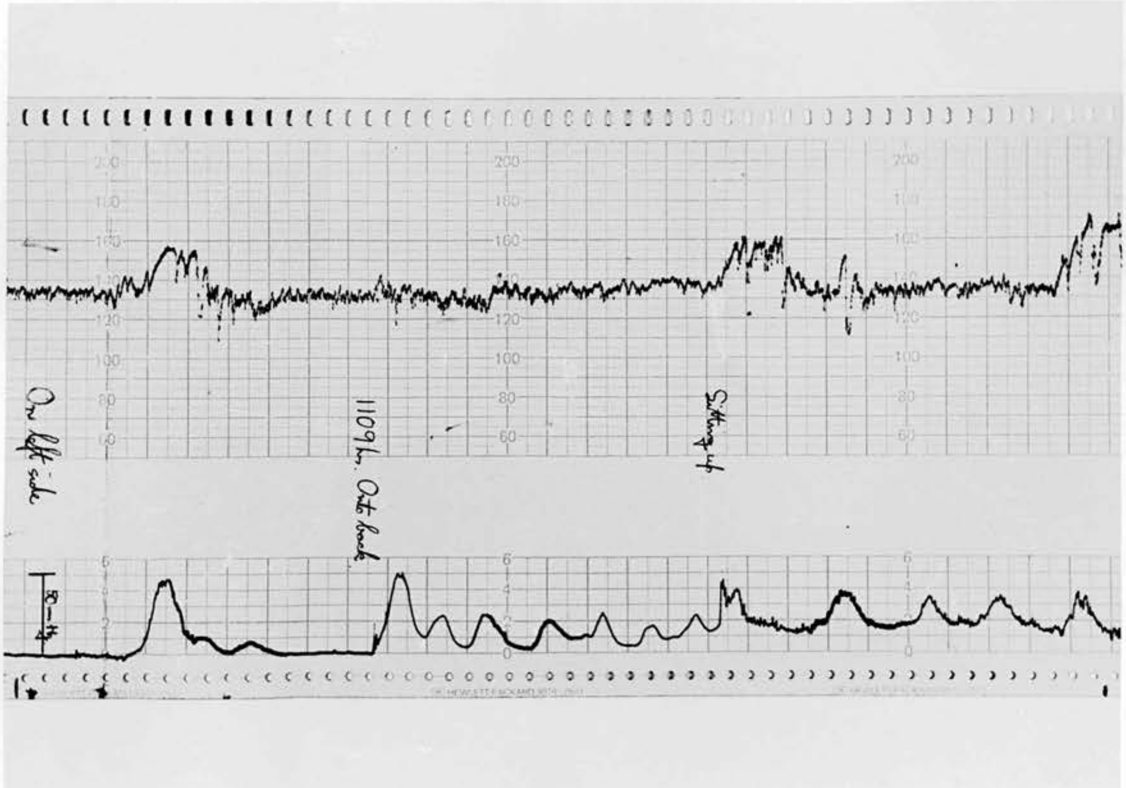


PLATE 27. Effects of Maternal Position on the Contraction Pattern.

about 30mms. Hg. Clinically, therefore the contractions were recorded for ten to twelve seconds total short of their actual duration.

Philpott's routine of describing clinically palpable contractions of greater duration than forty seconds as being effective would appear to be correct. The actual contraction lasting for fifty seconds plus, invariably reached a level of 45mms. Hg., generally accepted (Claye and Bourne, 1963), as strong. These points confirm the acceptability of the contraction duration method of measurement described by Philpott and the reliability of their clinical assessment.

During the study, the marked effect of maternal position changes on the uterine contraction pattern, was noted. As demonstrated in Plate 27, the contractions were stronger, less frequent and with a lower resting tone with the patient on her side, than supine. These changes occurred predictably, irrespective of whether the contractions were spontaneous or Oxytocin induced and they occurred immediately with the change in position. Although described by Besch (1954), Lorand and Pogany (1954) and Caldeyro Barcia (1963), who first established the law of position twelve years ago, the influence of position changes during labour has received little attention. The mechanism by which the changes of position have such important effects, are completely unknown, but obviously, the lateral position produces a more efficient contraction pattern and is safer for the baby. It is therefore not only because of the better known risk to the fetus from Hypoxia due to the hypotensive syndrome (Holmes, 1953; Walters and Linn, 1970) but also because of the contraction pattern effect, that the most advantageous position in labour is the lateral one.

THE FETAL HEART RATE PATTERN

It has been demonstrated (Caldeyro Barcia et al 1966);(Day et al,1968);

(Steer and Beard, 1970);(Philpott and Stewart, 1973), that the fetal condition can be accurately assessed by traditional methods without expensive equipment. In fact Stewart Taylor, (1975) describes a study which concludes that the clinical mode of monitoring is superior to the electronic as a guide to management in labour!

By careful counting of the heart rate before, during and after a contraction with a fetal stethoscope, the fetal heart rate pattern can be determined and decelerations, whether early, late or early prolonged, described. If there is difficulty in auscultation during the contraction, then the fetal heart rate should be listened to immediately the contraction has ceased - remembering that the actual exceeds the true contraction by about five seconds. If the fetal heart has not returned to its normal rate, then an early prolonged or a late deceleration is present.

In a separate study into clinical monitoring, (Philpott and Stewart), the ability of an experienced midwife to detect the patterns clinically was tested. She was asked to make her own clinical assessment of a fetal heart rate pattern by listening for fifteen seconds before, during, and after a contraction at the same time as it was being recorded on a screened off cardiotocograph. During the monitoring of twenty patients with fetal distress, the midwife was tested on one hundred segments of trace containing varying fetal heart rate patterns. She was correct in her clinical recognition of these one hundred patterns in 93% of cases. The main problem encountered was that the fetal heart not infrequently became inaudible at the height of contraction, but the use of the relatively inexpensive portable ultrasonic fetal heart monitor overcame this problem. (Plate 11).

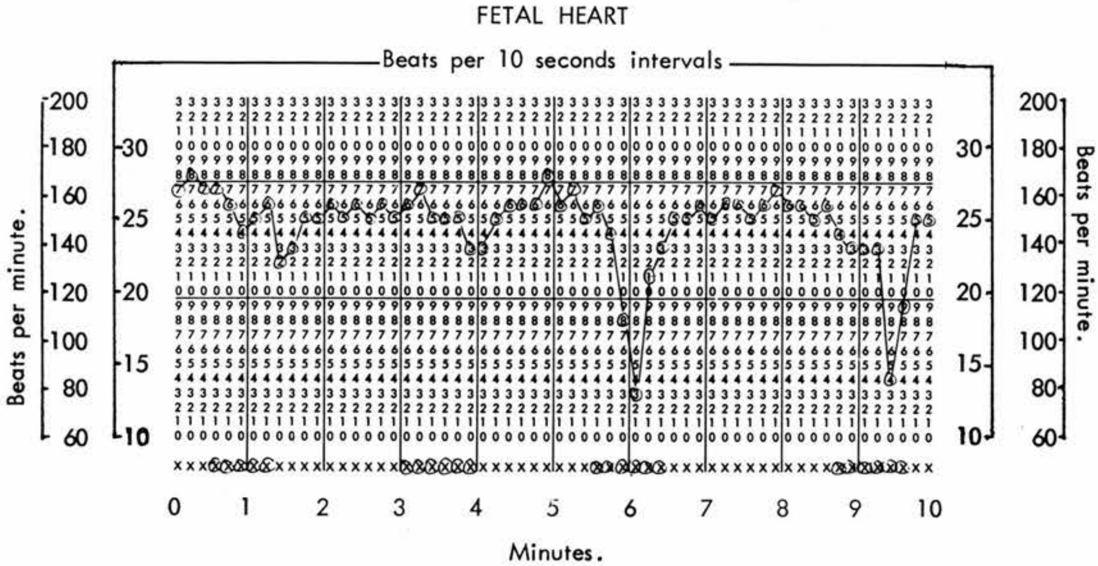
Caldeyro Barcia et al (1966) also describe a simple method for obtaining a continuous record ofthe fetal heart rate by serial counting over fifteen second periods with five second intervals begun during and continuing after a contraction - the duration of the contraction being recorded independently by a separate observer. Day et al (1968) suggested a similar method. Steer and Beard (1970) found the optimal counting period to be ten seconds, and demonstrated that a reliable picture of fetal heart rate patterns could be obtained by counting over sequential ten second periods using a chart converting ten second sequential counts into the equivalent number of beats per minute, a record being obtained as shown in Figure 20. Because of the delay in detecting both the start and the finish of a uterine contraction by hand, the contraction was recorded in the ten second period in which it was first felt and in subsequent periods, but not in the period when it seemed to finish.

Such manual records do not reveal "instantaneous" or beat-to-beat variation in fetal heart rate, but this is of only minor importance. Though loss of beat-to-beat variation may add to the significance of an abnormal fetal heart rate pattern, there are rare exceptions to the general rule that when the fetus is asphyxiated, loss of beat-to-beat variation is accompanied by an abnormal fetal heart rate pattern; conversely, when the fetus is in good condition, loss of beat-to-beat variation is accompanied by a normal pattern (Beard et al, 1971).

HEAD LEVEL

As described on page 99 , the head level measured radiologically was found to compare closely with the level clinically using the method of both Crichton and Notelowitz.

With close attention to detail therefore, a high standard of clinical care can be attained. The three parameters, uterine contraction pattern, fetal heart rate pattern and the head level can be accurately documented without recourse to more sophisticated apparatus and elaborate techniques. Similarly, the cervical dilatation and moulding score, as described on page 57 , can be accurately recorded.



Instructions : (1) Ring beats counted every ten seconds

(2) Ring x if contraction felt during count but not when it finishes.

FIGURE 20. Conversion chart for Fetal Heart Rate counts.

FINAL DELIVERY METHOD

FINAL DELIVERY METHOD

The crucial decision of how to effect delivery can be a difficult and uncertain one for the operator. It must be re-iterated that in the African situation, always compatible with safety to mother and infant, the unnecessary Caesarean Section which can be hazardous must be avoided. Mitford Baberton and Sibthorpe (1964), writing from East Africa, reported a 2.37% maternal mortality! At the same time, symphysiotomy dome too readily, may be unnecessary, while if done for the incorrect reason with the degree of cephalo pelvic disproportion too great, the consequences may be disastrous. The decision regarding mode of delivery therefore particularly requires rules to assist the doctor.

In this study, arbitrary criteria basing mode of delivery on the presence or absence of fetal distress, the dilatation of the cervix, the head level and the amount of moulding, were evaluated. These criteria, as displayed in Table 34 follow those described by Oram et al (1969) Simons and Philpott (1973) and Philpott (1973), but with some modifications.

(1) The moulding as described on page 57, was used objectively as a score.

(11) In assessment of head level, Notelowitz's method (page 53 was used, to confirm the level as estimated by Crichton's method.

(111) Before the vacuum extractor was applied, or symphysiotomy carried out, the cervix had to be fully dilated.

Assuming that delivery was not pending after thirty minutes of organised bearing down in the second stage, in the absence of fetal distress, the delivery method was determined as set out in Table 34.

If the cervix were fully dilated, but with fetal distress present then as regards the mode of delivery (Table 34) those patients in group two by head level and moulding score, were delivered as if in group three.

Thus for example, in the presence of fetal distress with the head one fifth above the brim, and 5 +'s of moulding present, symphysiotomy was indicated.

Additional criteria were applied in the case of Symphysiotomy. The procedure was contraindicated where the primigravid mother was over thirty years of age, was obese, had any musculo -skeletal disorder, or where the infant was estimated to be other than average (2,500/3,500gms) in size. In these cases Caesarean Section was carried out.

Similarly where the cervix was not fully dilated and immediate delivery was required, Caesarean Section was indicated.

TABLE 34

CRITERIA FOR DELIVERY

Group	Head level (Fifths above brim)	Moulding Score	Mode of delivery
1	0/5	Regardless	Instrumental
	1/5	0 to 4	
2	1/5	5 or 6	Instrumental trial
	2/5	0 to 4	
3	2/5	5 or 6	Symphysiotomy and Vacuum extraction
	3/5	0 to 4	
4	3/5	5 or 6	Caesarean Section
	4/5 and higher	Regardless	

TABLE 35

FEATURES DECIDING DELIVERY AND THE IMMEDIATE FETAL RESULT

Mode of Delivery	Number	Degree of Disproportion	Indication for Delivery	Mean 1 minute Apgar
Caesarean Section	44	Major	Failure to progress-16% Fetal Distress-18% Both -66%	6.7
Symphysiotomy	6			
Vacuum Extraction	19	Minor	Failure to progress-85.7% Fetal Distress- 0% Both -14.3%	7.8
Forceps Delivery	2			
Spontaneous vertex Delivery	11	Nil	Nil	8.6

RESULTS

Out of the total of One Hundred and Eleven cases where the cervicograph had crossed the Action Line, sixty three patients were delivered by Caesarean Section, thirteen by Symphysiotomy, twenty-two by Vacuum Extraction, two by Obstetric Forceps, and eleven spontaneously.

Table 4 (page 78) describes the group where there were complications additional to dysfunctional labour which might have influenced the timing and mode of delivery.

In this section, the disproportion groups, where there was no extra complicating factor are looked at. Table 35 displays the numbers delivered by the various methods, the main features deciding delivery, and the immediate fetal result.

Indications for Delivery

Fetal distress as evidenced by a falling pH played a greater role in determining mode of delivery in the major disproportion group than in the minor.

Caesarean Section

All Caesarean Sections were carried out under epidural analgesia. In six, further local infiltration was required. In three cases, as already described, this did not suffice and intravenous "Ketalar" along with "Valium " was used.

Of the Caesarean Sections, 72% were carried out before full dilatation and with one exception (Case 1) all were the initial treatment of choice. Table 36 shows the findings at operation. 46% were found to have fairly marked bladder oedema, but none had any residual urinary problems. In 18%, the lower segment was noticably thin and ballooned, but all were intact. In no case was Caesarean Section required following failed symphysiotomy.

TABLE 36

FINDINGS AT CAESAREAN SECTION

Peritoneal free fluid	62%
Ballooned lower uterine segment	18%
Bladder oedema	46%

TABLE 37

VACUUM EXTRACTION - NO. OF PULLS REQUIRED TO EFFECT DELIVERY

Number of pulls	1	2	3	4	5	6
Number of patients	-	4	9	6	-	-

SYMPHYSIOTOMY AND VACUUM EXTRACTION

In three of the six cases, (Cases II, III and IV) Symphysiotomy was proceeded to following unsuccessful trial of vacuum.
In two of the three elective Symphysiotomies (Cases V and VI) the rules were overstepped and Caesarean Section was nearly required following Symphysiotomy.

In all cases, the vacuum cup was applied and the time interval from the decision to undertake Symphysiotomy, to the time of delivery was less than fifteen minutes.

There were no untoward sequelae following Symphysiotomy and all patients had been discharged home by the thirteenth day, symptom free, with no locomotor or urinary problems.

VACUUM EXTRACTION.

Ten of the total of twenty-two Vacuum Extractions, were performed on a Trial Basis, and of these, as already described, three required Symphysiotomy.

The head at time of application in the nineteen cases, was occipito anterior in ten and occipito transverse in nine. Rotation to occipito anterior, occurred in all, on the perineum.

Table 37 indicates the total number of pulls required to effect delivery.

FORCEPS DELIVERY

In two cases, (Cases VII and VIII), caput formation was considered excessive. In each instance, the vertex was occipito anterior and delivery was successfully effected by using Haig Ferguson forceps.

SPECIAL CASES

In Case I following unsuccessful Trial of Vacuum, it was decided to carry out Caesarean Section rather than Symphysiotomy, as the baby was considered too large. Following five hours of oxytocin augmentation, the cervix had reached full dilatation. After thirty-five minutes of organised pushing in the second stage, the head was two-fifths above the brim, occipito anterior and with four pluses of moulding. The Vacuum cup was applied, but traction with three contractions failed to produce significant descent. Lower segment Caesarean Section was proceeded to and the infant weighing 3,900 gms and with an Apgar of 5 : 8 delivered.

Cases II, III and IV demonstrated situations beyond the upper level of suitability for delivery by vacuum extraction. In each of the three, the cervix was fully dilated and there had been no evidence in labour of fetal distress. Trial of Vacuum following three tractions failed to achieve adequate descent and Symphysiotomy was carried out.

In Case II, the head was two-fifths above the brim, with six pluses of moulding. Following Symphysiotomy, the vacuum cup was reapplied and the infant weighing 3,200 gms and with an Apgar of 7 : 9 easily delivered.

In Case III, the head was three-fifths above the brim with three pluses of moulding present. Symphysiotomy produced an easy delivery. The infant weighed 3,400 gms and had an Apgar of 6 : 10.

In Case IV, the head was two-fifths above the brim with five pluses of moulding present. Again Symphysiotomy following unsuccessful Trial of Vacuum, produced an easy delivery of a 3,000 gms infant in good condition, Apgar 8 : 10.

From these three cases, the criteria as outlined in Table 34 for instrumental delivery and Symphysiotomy were confirmed as correct.

On two occasions the rules (Table 34) were overstepped and Caesarean Section was nearly required following Symphysiotomy. In neither case, was there evidence of fetal distress and the cervix was fully dilated.

In <u>Case V</u>, with the head three-fifths above, right occipito anterior and a moulding of six, Symphysiotomy was carried out, and the vacuum cup applied. After four strong traction efforts, the infant was still undelivered, and it was considered that, in fact, Caesarean Section had become indicated. A fifth pull, however, proved successful and delivered the infant weighing 3,150 gms and with an Apgar of 5 : 10.

In <u>Case VI</u>, a similar situation occurred. Before Symphysiotomy, the head was occipito anterior, three-fifths above and with five pluses of moulding present. The infant was delivered with the fifth pull, weighed 3,250 gms and was in satisfactory condition.

These two cases support the reliability of the criteria indicating Symphysiotomy on the one hand and Caesarean Section on the other.

In <u>Cases VII and VIII</u>, because of excessive caput formation, forceps were applied, to effect delivery after delay in the second stage. In each case, the head was one-fifth palpable abdominally, with four pluses of moulding present, and in the occipito anterior position. Caput formation was very marked. Haig Ferguson forceps were applied and a straightforward delivery achieved. The infants weighed 3,010 and 3,300 gms. and were in good condition.

DISCUSSION

The criteria for the method of delivery as tried and set out in Table 34 have proved correct and reliable, are supported by the clinical results, and are further substantiated by the cases of interest outlined.

The successful application of these rules for delivery, is however, totally dependent on the accuracy of the clinical findings - the two crucial estimations being the head level and the amount of moulding present.

Head level estimated abdominally is much more meaningful and accurate than when assessed vaginally, where the relationship to the ischial spines can dangerously mislead in the presence of caput and moulding. Notelowitz's method, (1973) very usefully confirms that level obtained following Crichton's routine. In a thin patient with an epidural analgesic, accuracy is easy to attain. As regards moulding, the amount present can be objectively and accurately scored as already described (page 57)

INSTRUMENTAL DELIVERY

In the confined space of the contracted pelvis, where instrumental delivery has become indicated, the vacuum extractor should be the instrument of choice. The room otherwise taken up by the forceps blades, is spared for rotation, which the vacuum extractor allows to take place at the optimum level. The advantages over forceps are stressed by Chalmers (1968). Grech (1967) reported a marked fall in perinatal mortality from the 15.9% associated with difficult forceps. Further, Snoeck (1960) stated that when using the vacuum extractor, the intra cranial pressure was only 1/20th of that present when forceps were employed. The instrument is simpler to use than obstetric forceps. At the same time however, it is equally easy to abuse! Maternal tissues can be damaged from incorrect application. In the presence of cephalopelvic disproportion, particularly, accurate checks must be made to ensure that the fetal head is in factdescending, and not the scalp alone! To avoid abuse, the rules as outlined on page 68 , must be observed.

There is the occasional situation where forceps are preferable to the vacuum extractor. As instanced in this investigation, in two cases, where the caput formation was considered excessive, forceps were applied.

SYMPHYSIOTOMY

Symphysiotomy can be the alternative to either a Caesarean Section or to a dangerous vaginal delivery. Its additional advantage is that for future pregnancies, the pelvic area can be permanently increased by as much as 25% (Lawson and Stewart, 1967). Technically easy to perform, the main difficulty in the procedure lies in choosing the case correctly. There is no such thing as a "Trial of Symphysiotomy". If done in the wrong case, not only might Caesarean Section still prove necessary to deliver the infant but such complications as haemorrhage, vaginal, bladder and urethral damage or pelvic instability might occur. Symphysiotomy must therefore be restricted to certain well defined categories. It is mandatory that the correct indications and conditions be present before it is undertaken.

The baby must not be too large, else the pelvic halves may be pushed too far apart. Nor must it be too small. If cephalopelvic disproportion is present with a small infant, then subsequent pelvic enlargement may still leave the patient with a contracted pelvis.

It has been suggested by Philpott (1972) and others, that Symphysiotomy can be undertaken before full dilatation. As a rule this would seem incorrect. The procedure might, in fact be unnecessary! At the same time, if delivery does not quickly follow Symphysiotomy, prolonged strain on the sacro iliac joints will create subsequent problems. It is considered therefore, that the cervix must be fully dilated at time of operation.

Done correctly, Symphysiotomy is a valuable procedure in the circumstances pertaining in African Obstetrics. In Western practice, where it has fallen into disrepute, the dangers may have been overstated or may perhaps have been due to improper use (Lasbrey, 1963);(Chassar Moir and Myerscough, 1972). It is, however, more likely that the android funnelled pelvis associated with cephalopelvic disproportion in the European patient does not lend itself to Symphysiotomy as does the particularly suitable round small pelvis, described earlier, of the African.

CAESAREAN SECTION

Caesarean Section as already stressed must not be done unnecessarily. The operation however becomes indicated in the following circumstances:-

When fetal distress develops before full cervical dilatation;

Where there has been a failure of adequate progress after up to six hours of Oxytocin augmented Trial of Labour;

Where at full dilatation, the head is four-fifths or higher above the brim, or three-fifths above with a moulding score of 5 or 6;

Or, in the patient who is not suitable for Symphysiotomy, when the head is two-fifths above the brim with a moulding score of 5 or 6, or three-fifths above with a score of up to 4.

SELECTION OF THE FINAL ROUTE

All the care taken in the first stage of labour, is to no avail if the correct principles are not adhered to, in selecting the final method of delivery.

The second stage of labour should be assisted if it takes longer than thirty minutes.

Assisted delivery should never become a difficult, hazardous procedure. The days of dexterous but risky manipulation are past. If the delivery is difficult, the wrong procedure has been selected.

In the presence of fetal distress, if vaginal delivery is not certain to be easy, then, because of the danger of adding insult to the injury of an asphyxiated fetus, the disproportion should be relieved by Symphysiotomy or delivery effected by Caesarean Section.

Finally, the delivery method chosen (Table 34), will depend upon the presence or absence of fetal distress, the abdominal head level, the degree of head moulding and, where indicated, the suitability of the patient for Symphysiotomy.

CONCLUSION

CONCLUSION

In this study, the problem of cephalopelvic disproportion in the primigravida, has been considered. Recognition of the presenting features and management have been evaluated. It has been shown that disproportion in the otherwise normal primigravid patient can be safely managed with a correctly and well controlled Trial of Oxytocin.

This fact however does not hold in the multiparous patient, where cephalopelvic disproportion can be particularly difficult to recognise and labour treacherous to manage. While in the primigravid, the cervical response to disproportion, is one of slow or absent dilatation, in the multiparous patient the cervix spontaneously can dilate rapidly in the presence of marked disproportion, to full dilatation, during which process, the uterus may rupture. The use of Oxytocin to induce or augment labour, adds further risk to the hazard of management of the multiparous patient, in a population group, where contracted pelvis is common, where cervical dilatation is unreliable and where the head tends to remain high in the pelvis until late in the first stage of labour.

Further study into this separate problem of cephalopelvic disproportion in the multipara is required. Where cervical dilatation can be so misleading, the various other parameters discussed in this investigation, head level, moulding score, fetal response and pelvic dimensions, become all important.

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I apologise for the poor quality of the negative from which Plate 1 was developed. I am grateful to Professor J.B. Lawson for permission to reproduce the line drawings in Diagrams 7 and 8, from his text book.

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